M.S.L.A.P.

Modular Spectral Line Analysis Program Documentation

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by Charles L. Joseph

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1) You are not permitted to distribute the standard source code to any other site. There are several distribution centers that supply standard source code.

2) You are permitted to distribute additional modules (subroutines) written for use with MSLAP to other sites, provided the new code meets documentation requirements.

3) You are permitted to alter the standard source code as you desire, but you must maintain the original copyright notice in the source file and you may not distribute the altered code without written authorization. Also, any alterations to the standard source code must meet documentation requirements.

4) If you represent a guest user facility, you are not permitted to incorporate modifications that remove the modularity of MSLAP, thus making it difficult for guest users to customize MSLAP.

The Modular Spectral Line Analysis Program (MSLAP) was written and copyrighted by Charles L. Joseph and Edward B. Jenkins

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AND

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Table of Contents

I. Introduction to MSLAP

The Modular Spectral Line Analysis Program (MSLAP), as its name implies, forms a backbone of programs, designed so that customized subroutines can be inserted and implemented with minimal difficulty. MSLAP, a third generation package of software, also is a complete and powerful stand-alone program for analyzing spectra, providing the basic structure to identify spectral features, to make quantitative measurements of these features, and to store the measurements for convenient access. MSLAP can be used to measure not only the zeroth moment (equivalent width) of a profile, but also the first and second moments. Optical depths and the corresponding column densities across the profile can be measured as well for sufficiently high resolution data.

The software was developed for an interactive, graphical analysis where the computer carries most of the computational and data organizational burden and the investigator is responsible for all judgment decisions. Cursors are used not only to provide graphical input, but also for logical control branching. It employs sophisticated statistical techniques for determining the best polynomial fit to the continuum and for calculating the uncertainties. MSLAP, making use of data structures, provides substantially more capabilities in the handling, presentation, editing, and manipulation of intermediate results than do its predecessors.

MSLAP is written in the Interactive Data Language (IDL) and issues some commands to the UNIX operating system. While MSLAP has not been transported to a VMS environment, there is no apparent reason why it could not be. MSLAP is specifically designed for workstations, running in either an X Window or Sunview environment.

The basic structure of this document is as follows. A method for getting started quickly is given in §II, where it is assumed that MSLAP has already been installed in some convenient library directory and the reader is anxious to try running MSLAP for the first time. Section III provides a detailed, step-by-step description of the six major portions of the program. Some common mistakes in data handling are listed as cautions in §IV. The documentation for modifying and customizing MSLAP is given in §V and for installing MSLAP on system is in §VI. Finally, for convenient access, Appendix A contains a listing of the source code, including a table of contents, while the three data structures used by MSLAP provided in Appendix B.

II. Quick Start

It has been said that a fundamental difference between men and women is that men do not like to read directions, preferring to get started quickly, while women do read the directions, opting to do the job only once. Whatever your persuasion, this section is designed to get the novice going with the minimal amount of reading. Once program has been started, the novice can rely on the instructions provided by MSLAP as it runs or rely on §III, which provides a more detailed description.

a. Getting Ready

MSLAP runs in either an X Window or Sunview window environment. Sunview is perhaps the more sophisticated system, but is specific only to Sun Workstations, while X Windows is a industry standard that is available on most machines. X Windows has the added advantage that a user can run software on a remote machine, displaying the graphics and printed matter on the local console. It is not possible, however, to run MSLAP on a remote machine without

a local workstation or terminal that supports windows.

Both Sunview and X Windows can be configured in many different ways. If you are at a Guest Facility, the chances are that your machine automatically starts one of these systems when you log onto the workstation. MSLAP needs a large window in the lower left corner for printing instructions. If you do not have a window in the lower left corner and are not an experienced user of one of these environments, it is recommended that you copy the appropriate files from the MSLAP library to your login directory. Your system manager has placed the MSLAP library in the directory: _____. For X Windows, the files are .x11defaults, .twmrc, and .xinitrc. For Sunview, only .sunview is needed. If necessary, make sure that your path includes:_____. (Your path is found either in your .login or .cshrc file and can be changed using your favorite editor.) Then type: "source .login" to reset your path name. Start the window system by typing either:

"sunview"

or

"xinit ; kbd_mode -a ; clear"

for Sunview or X windows, respectively. The latter could be aliased to something simpler or either could be place in your .login file. Now each window that appears, effectively represents a separate terminal. Each time the cursor, associated with the mouse, is placed into a window, that window becomes the "active terminal". (In some cases, it is also necessary to click one of the mouse buttons to activate the new window.) All other windows, however, can still continue processes that were previously started, including output printing.

Place the mouse cursor into the large window in the lower left of the screen. Change to the directory where you want to run MSLAP and copy from the MSLAP library the files: mslap.pro and dgets.pro You are now ready to proceed to run MSLAP.

b. Running MSLAP

MSLAP is written in the Interactive Data Language (IDL). Use the mouse to place the cursor in the large window in the lower left corner of the screen and start IDL by typing: "idl". Once you see the prompt "IDL>", type: ".run mslap.pro". A menu of options will then appear. The first two options allow the researcher to scan quickly through the spectra, searching for features, identifying the species in look up tables, making measurements of the profiles, and storing all of this information in a data base for latter use. The second option also produces optical depths as a function of velocity across the profiles.

In options 1: and 2: of the FIRST MENU, a series of questions appear to configure MSLAP. The default values for all Yes/No questions is assumed to be NO except for answers of either a "Y" or a "y".

The main body of MSLAP begins after these questions are answered. In this portion of the software, the mouse is used to input graphical information to the program as well as to control the data reduction. The basic philosophy of the mouse operation is as follows. The left button should be used in response to the general flow of the program while the middle button is used to signal the computer that the researcher wishes to move on to the next task. For

example when the main spectrum is showing, the left button causes the computer to attempt to identify features of interest (the first task MSLAP expects to perform) and the middle button causes the computer to go fetch the next portion of the spectrum. Another example would be in the continuum- fitting portion of MSLAP. There, the left mouse is used to select the portions of the spectrum to be fit, while the middle mouse button indicates all portions are selected – now go on and do the fits.

Finally, all other branching is accomplished by using the right mouse button, which causes a Menu of additional options to appear. The researcher is invited to examine this Menu from time to time. There is no harm in striking the right mouse button since "Take No Action" is always one of the options. Note: once the Menu appears, the left mouse is used to make the selection. This Menu can be modified easily and customized routines inserted into it by editing the mslap.pro file that was transferred to your working directory. (See §V for details on modifying this file.) The researcher is encouraged to examine this file once he or she has become familiar with the operation of MSLAP.

At this point put down this manual and concentrate on running MSLAP. The program provides self-contained directions that appear in the lower left window. However, if you run into trouble, §III of this manual has a detailed, step-by-step set of instructions.

III. Step-by-step Description

This section is organized into 6 subheading that represent each of the 6 options from the first menu that MSLAP displays when started. This menu appear as follows:

```
May 17, 1990
;
;
; ************************************************************************
;                  Modular Spectral Line Analysis Program
;                       M.S.L.A.P.  version 1.0
;
;     copyright (c) 1991  by Charles L. Joseph and Edward B. Jenkins
;        All rights reserved.  A license may be obtained from the
;         first author or from an authorized distribution center.
;
;       This software distributed through: Princeton University
; ************************************************************************
;
;
;               THE FOLLOWING OPTIONS ARE AVAILABLE:
;
;
;             1:    Measure Profile Moments Only
;                      (Equivalent Width, Profile Centroid, etc.)
;             2:    Measure Moments and Optical Depths
;             3:    Manipulate Tabled Data
;             4:    Edit Tabled Data
;             5:    Analyze Column Densities vs Velocity
;                      on Option #2 Data
;             6:    Compare Data to Curve of Growth
;            10:    TO EXIT FROM THIS PROGRAM


Which option would you like ?
```

1: Measure Profile Moments Only

Option 1: of the first menu is for measuring the zeroth (equivalent width), first (velocity), and second moments of the spectral profiles. Both this and and the second option ask the same set of questions, which will be discussed below. The computer I/O will be displayed in small style type like this, while the descriptive narration describing these questions will be display in ordinary style type. Answers to the questions will be provided as an example.

The first two questions deal with establishing an output data file. In the case below, the output file name is called "test" and a file called "test.DTL" will be created or opened, depending whether the file already exists. If a file named test.DTL is found, the program examines the contents to see how many measurement have been made previously and reports this information to the user. The investigator then has the option of starting with a number of measurements already made or initializing (erasing) the contents of the file. Note: if you wish to save the previous work, but not combine new data to the file, answer the "Append new data to the old?" question with a "y" and exit the program later. For the purposes of this example, a "n" was used.

```
What is the output file name ?test

File Already Exists
          4 measurements have already been made.

Append new data to the old?
(Note: a NO will erase old data.)n
```

Next the program seeks to determine the radial velocity expected for the profiles. This information is used only to help select the correct entries in the Look Up Tables in order to identify the various spectral features. The information can be input in the form of Delta-Lambda/Lambda or as a Radial Velocity in km/s. If you are uncertain of the real value, enter a "0". The computer then mirrors the value that has been entered.

```
The radial velocity is used only to help identify species.
Enter 0 if you are uncertain of the real value.
Enter Delta-Lambda/Lambda or Radial Velocity for the source: 0
The Delta-Lambda/Lambda is:       0.00000
```

There are several Look Up Tables which contain the identification of various species along with important information such as the oscillator strength and rest wavelength. (See §V for details of the use and implementation of these tables.) MSLAP has the capability to search more than one of these tables automatically. In addition, a personal User Look Up Table, which is capable of holding up to 100 entries, is scanned.

Below is a list of Look Up Table Options. In the example, the investigator has requested both the Morton and Smith table of interstellar lines as well as a compilation of molecular bands be searched each time an identification is requested.

```
------------------------------------------------------------
Available lookup tables are:

      1)  Interstellar Lines  (Morton and Smith 1973 plus updates)
      2)  Molecular Hydrogen, HD, and CO
      3)  Options 1 & 2 Combined
      4)  Hot-Star Lines  (not implemented)
------------------------------------------------------------


Which one would you like ?3
```

Next the programs queries as to which dget (i.e. data-getting) routine is to be used and the name of the file holding the spectra. There are a number of data formats used by different observatories so it is appropriate for many users to keep several dget routines on hand. While only 5 dget routines are supported at a time, each researcher gets to incorporate the 5 that best meets his needs. (See §V for more details on the implementation of the dgets.pro file.) In the example, the investigator has requested a very specialized dget routine which reads data taken with an echelle spectrograph on a sounding rocket. This particular dget differs from the dget loaded into slot 3) because it contains information about the background level and associated errors. The file to be used is in another subdirectory: ../rocket and is named: imaps.

```
------------------------------------------------------------
DATAGET  Options:

      1) IUE Standard GO Files for High-Res. Spectra (DISKGET)
      2) NOT Being Used
      3) ASCII Format of Wavelength-Spectra-Quality-BG
      4) 1024-Element Stand-Alone Data
      5) IMAPS pseudo standard   (ASCII)
------------------------------------------------------------


Which one would you like ? 5


Enter complete INPUT Data Filename
Including the path if necessary ../rocket/imaps
```

The final question before the researcher is off and running is the issue of coherence length. The message is pretty much self explanatory, but its importance should not be slighted (see §IV). Note that the coherence length need not be an integer value. For example, if the value of a pixel is influenced only slightly by its adjacent neighbors, the coherence length could be 1.2 for instance. A non-integer value might also be expected if the data have been smoothed by a running-gaussian smoothing routine.

```
IMPORTANT: The coherence length is used to calculate ALL uncertainties.
It is the number of pixels influencing the value in a given pixel.
Thus, the coherence length must be 1 or greater.  For example, data
smoothed by a 3-point Running Box Car has a coherence length of 3.

What is the coherence length of the present data? 3
```

The main program then begins and the screen resembles Figure 1. Generally speaking, instructions appear in the text (lower left) window, indicating how the graphical input is to be made in the plot window. As this portion of the software starts, the following information is displayed in the text window. Particularly important pieces of information are always boxed.

```
New Data Have Been Read     --   Data Getting Option:       5

 ------------------------------------------------------------------
 | The background uncertainty frequently has a major impact on the  |
 | uncertainty of the various measurements.                         |
 | Current background is:       12.0000 with an error:      5.00000 |
 | Use the RIGHT Mouse Button if these are unsatisfactory.          |
 | Note: all graphical input is performed by placing the cross-hairs |
 |       at the point of interest and pressing a mouse button.      |
 ------------------------------------------------------------------

Left Mouse to Locate Feature to be Measured -- Need NOT be centered
Middle Mouse to GO ON, get new data
Right Mouse to bring up UserMenu of other options.
```

Notice that the last 3 lines contain the instructions for the use of the Mouse. These instructions are constantly being updated as you proceed through the program. Once you become familiar with MSLAP, your focus should move almost exclusively to the plot in the upper right window.

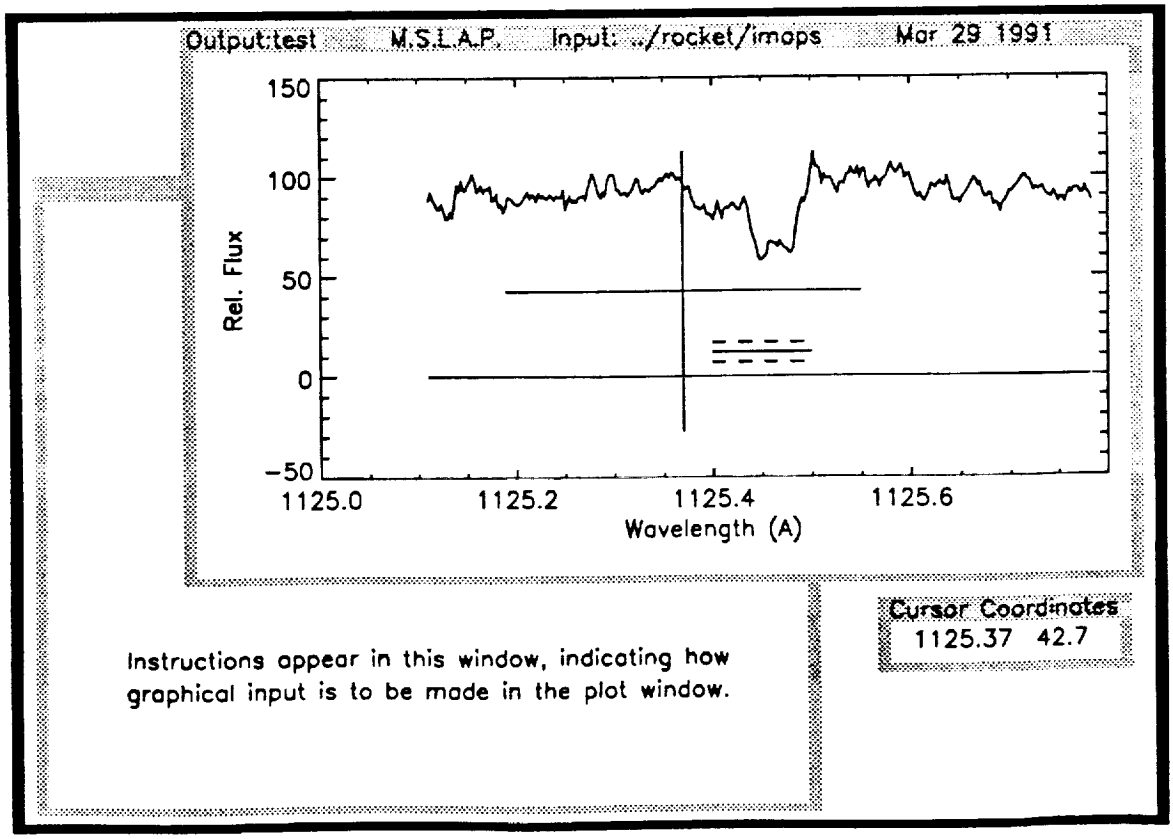


Fig. 1 showing the typical screen layout.

The plot in figure 1 has several features worth highlighting. In addition to the spectrum, there

is a data quality vector plotted. Not all data sets have such a vector, in which case it is set to zero as shown in figure 1. The three horizontal lines plotted between about 1125.4 and 1125.5 Å indicate the assumed background level and its uncertainty. This information is also printed in the text window, surrounded by a box, every time a new data is read. The graphical cross hairs or cursors are also depicted and as the Mouse is moved across the pad, the cursor moves accordingly. A small window, labeled Cursor Coordinates, provides continuous readout of the cursor location.

At this point, the branching possibilities become large and it is nearly impossible to provide a detailed description of each path on a step-by-step basis. The general philosophy, however, is to scan through the spectra, looking for spectral features of interest. The Center Mouse Button is reserved to indicate that the user is finished with the present task. Since the present task is to locate features to be measured, the Center Button indicates a request for new spectra. If your dget is configured for multiple portions of the spectrum in a single data file, striking the Center Button repeatedly displays pieces of the spectrum sequentially.

The Left Mouse Button is used to identify species by comparing the observed wavelength obtained from the cursor location at the time the button was struck to a set of laboratory wavelengths located in various Look Up Tables. Immediately after the Left Button is depressed, a small menu of options is provided as shown in Figure 2. The three closest matches from the requested Look Up Table(s) are always provided plus any close matches from the researcher's personal User Look Up table. There were no entries found from the User's Table in the example shown in Figure 2. The investigator must make a selection by moving the Mouse up or down and striking the Left Button. The current position is noted with an arrow and the potential selection is highlighted. Notice that "NONE - Return to Spectra" and "Input Identity" are also options. If the latter is chosen, the program will present a number of questions to obtain information, including species name, its rest wavelength, and its oscillator strength. This complete species identification can be used as a temporary set of variables or can be permanently stored in the researcher's personal table for subsequent access.

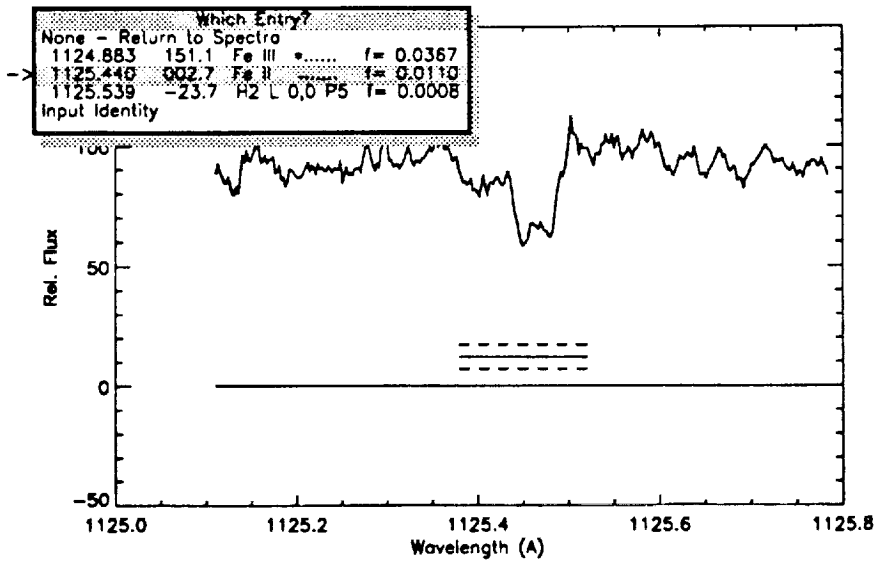


Fig. 2 showing the entries from the Look Up Tables

The Right Mouse Button provides all of the remaining flexibility. Striking it brings up the UserMenu of options shown in Figure 3. The novice is strongly encouraged to press this button, if for no other reason than to see the selection. This is a relatively safe operation since one of the options is to "Take No Action", just in case the Mouse Button was used inadvertantly.

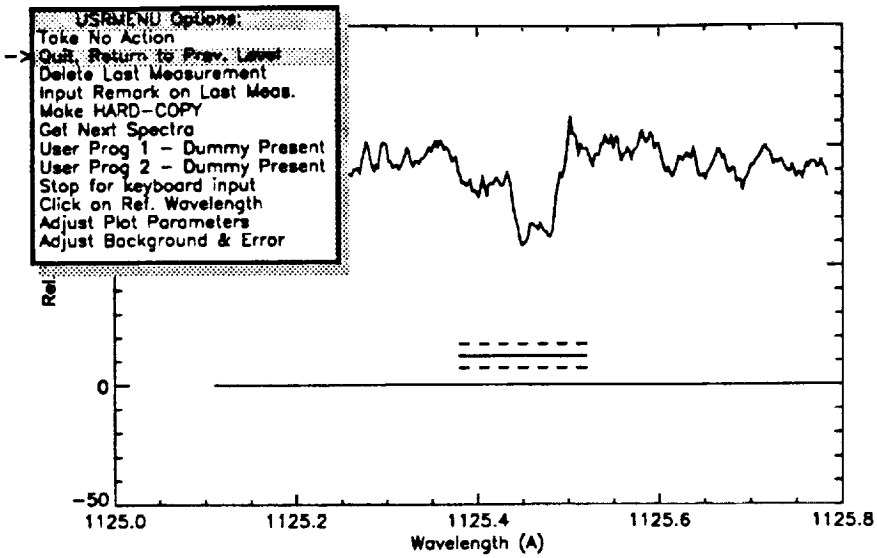


Fig. 3 showing the entries from the UserMenu

The UserMenu shown in Figure 3 works like all menus appearing above the plot window. A selection is made by using the mouse to place the arrow over the desired entry and depressing the Left Mouse Button. While the functionality of most of the entries are straight forward, the "Click on Ref. Wavelength" deserves a few comments. If this option is invoked, the user is solicited to move the cursor to any wavelength which he wishes "to declare" to be the rest wavelength and to click the Left Mouse Button. Now the abscissa coordinate, which is continually printed, reads in terms of velocity until the next graphical input. This capability is particularly useful when searching for a weak (1-2 sigma) feature after its doppler velocity has been determined from a strong line.

Once a species has been identified using the Left Mouse Button and making a selection as in Figure 2, the program enters the continuum fitting subroutine. MSLAP provides an expanded plot with the individual data points highlighted. In this portion of the software, the Left Mouse Button is used to isolate regions of the spectrum that are believed to be featureless, regions that will be used to perform a polynomial fit. The user may specify 15 or less regions, which are marked on the plot with numbers from 1 to 2, 3 to 4, 5 to 6, and so forth (see Fig. 4). As before, the Right Mouse brings up various MENUs, while the Center Mouse Button signifies all regions of interest have been identified (go on to the next task). Menu options that are available in the continuum fitting routine include: 1) defining discrete continuum points, 2) identifying additional profiles for measurment and corresponding species identifications, 3) adjusting the markers of the profile centers, and 4) bringing up the previous UserMenu of options.

Once the featureless portions have been identified, the program calculates polynomials fits of order 1 through 7. Then, MSLAP, starting with a polynomial of order 1, sequentially tests the polynomials of increasing order, searching for the case where no statistically significant

improvement of the fit is realized by polynomials of higher orders. Specifically, the next higher and next, next higher orders are tested for polynomials up to order 5. The program uses F Distribution Tests with a 5% significance to make this choice.

Then, a menu of options appears over the plot as shown in Figure 4. This menu is presented with MSLAP's choice of polynomial being indicated. The user can over ride the automatic selection of the order number, 4 in this particular case. He can in fact over plot various continuum fits until he is satisfied. Simultaneously, the following instructions plus a reminder of MSLAP's choice appear in the text window:

```
The recommended Order is 4 (highlighted), but you may select another.
To assist in other choices: X is the observational difference in the
reduced chi squares divided by the reduced chi square, which if larger
than the theoretical F(1,n) indicates that going to the next higher order
polynomial is justified statistically.  Y is similar to X except it is
for comparison to F(2,n), an order that is 2 higher.  The F Distributions
are at the 5% confidence level for:      180 points.

 Select the Order of the Polynomial
        - Other Polynomials may be examined before deciding.
        - Selecting order 4 implies use that polynomial.
```

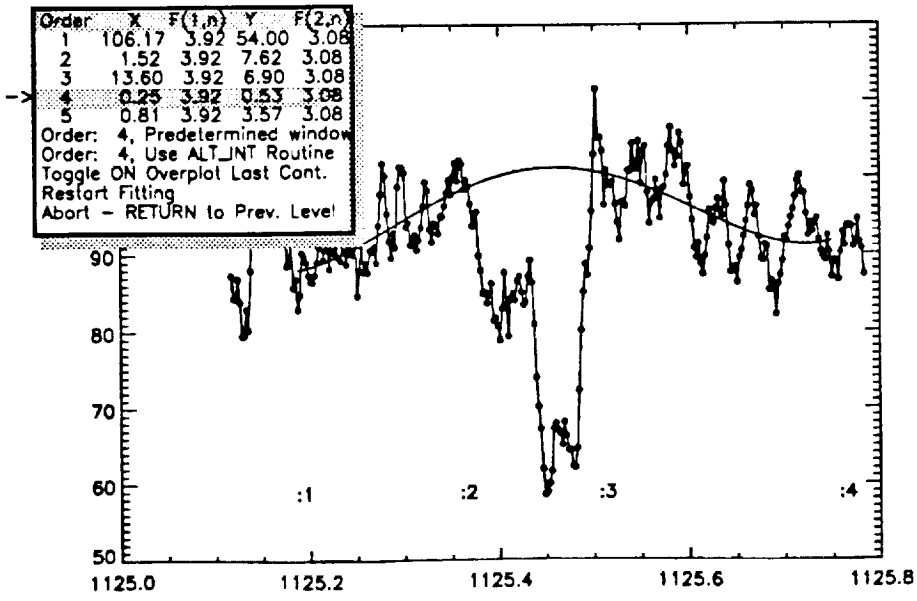


Fig. 4 showing the selection for the polynomials

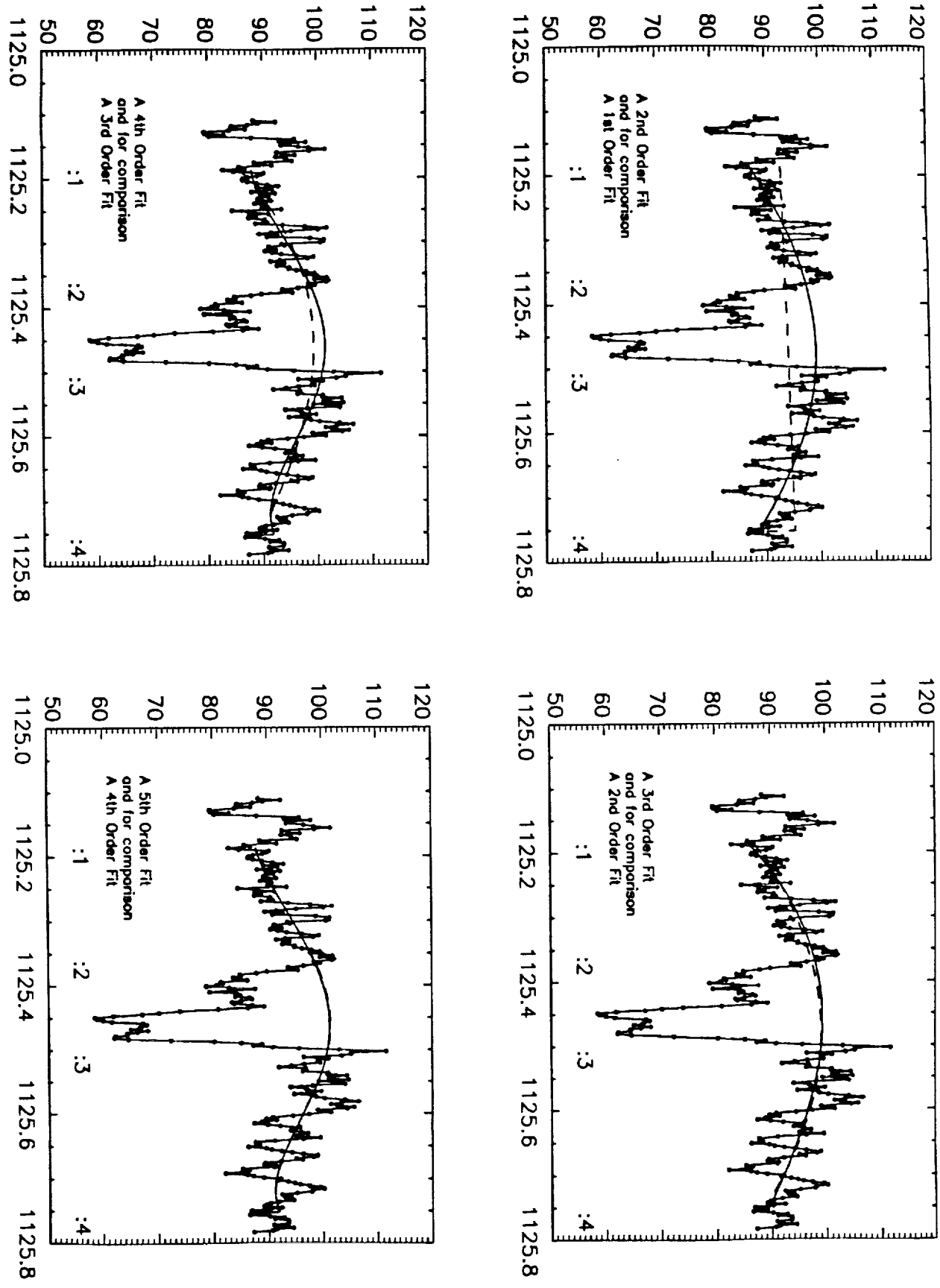
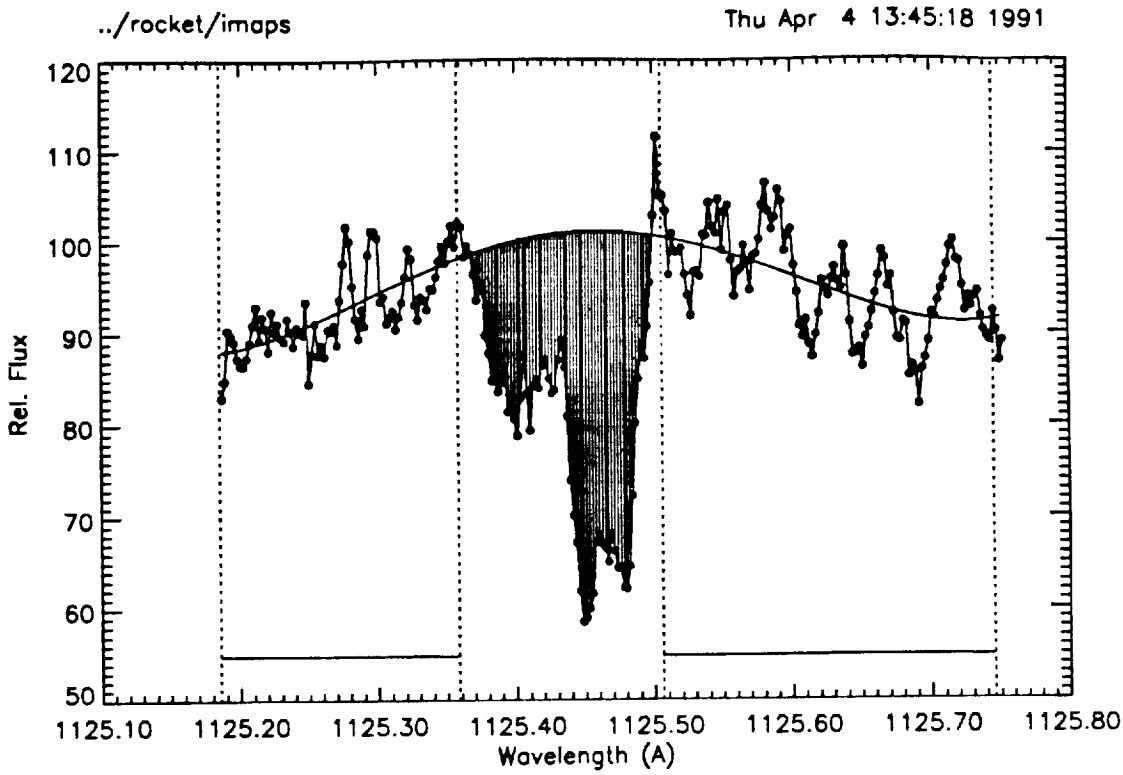

A 2nd Order Fit
and for comparison
A 1st Order Fit
A 3rd Order Fit
and for comparison
A 2nd Order Fit
A 4th Order Fit
and for comparison
A 3rd Order Fit
A 5th Order Fit
and for comparison
A 4th Order Fit
120
110
100
90
80
70
60
50
1125.0
1125.2
1125.4
1125.6
1125.8
:1
:2
:3
:4

Figure 5

Figure 5 shows several polynomial fits. For comparison, a polynomial with an order number that is one less is also plotted as a dashed line. (These were made using one of the options shown in Figure 4.) In this example, there is a significant difference between a polynomial of order 1 and 2, but not much difference between orders 2 and 3. There is also significant changes between orders 3 and 4, but not between 4 and 5 or between 5 and 6 (not pictured).

A polynomial is finally determined by selecting the order number that is currently plotted. Notice that there are two entries that always indicate the order number currently plotted, but request either the use of the alternate integrating routine be used or a fixed sized integration window. The latter allows the user to specify some predetermined velocity interval over which the measurements are to be made. If this window is undefined, MSLAP will prompt the user for input.

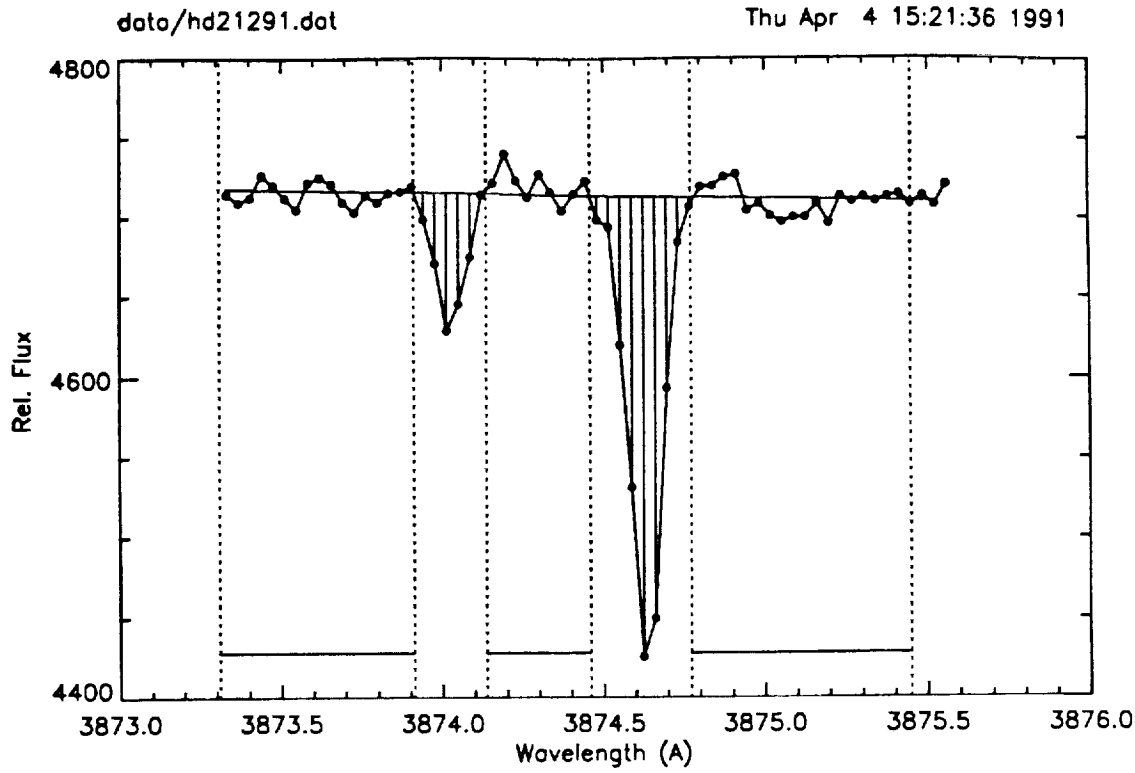
Finally, the cursors and Left Mouse Button are used to set the end points for the integrating region. (See §IV for cautions on setting this range.) The program then calculates the various moments and produces a plot such as the ones shown in Figures 6 and 7. The latter depicts a case where two profiles were identified as CN from the User's customized table and were simultaneously measured. Up to 4 profiles can be measured at one time. The solid, horizontal lines near the bottom of the plot indicate those regions between the dotted vertical lines that were used in the continuum fit. The area of integration is shadded. It is possible, for example to integrate only part of the profile.



Measurements in file: test.DTL Real S/N = 13.3
Apparent S/N Ratio: 23.0 based on 185 points with a Noise Coherence Length of 3.0
Continuum was fit with a polynomial of order: 4 0.25 0.53
BG (background) was taken to be: 12.0 +/- 5.0
For Fe II ..... 1125.440 error contributions from BG: 0.0018 0.002 0.024
Errors below are the Addition in Quadrature of the Background and RMS-Noise Errors

Species	Lab. Wave.	f	Obs. Wave	EQW (A)	1st (km/s)	2nd (km/s/s)
Fe II	1125.440	0.0110	1125.445	0.0323	1.245	72.094
			Errors:	0.0023	0.433	4.905

Fig. 6 showing the results for a single profile



Measurements in file: test.DTL Real S/N = 548.6
Apparent S/N Ratio: 548.6 based on 47 points with a Noise Coherence Length of 1.0
Continuum was fit with a polynomial of order: 1 1.42 2.11
BG (background) was taken to be: 0.0 +/- 0.0
For CN R(0) ..... 3874.608 error contributions from BG: 0.0000 0.000 0.000
Errors below are the Addition in Quadrature of the Background and RMS-Noise Errors

Species	Lab. Wave.	f	Obs. Wave	EQW (A)	1st (km/s)	2nd (km/s/s)
CN R(0)	3874.608	0.0338	3874.628	0.0077	1.586	15.469
			Errors:	0.0002	0.550	16.462
CN R(1)	3874.000	0.0228	3874.025	0.0020	1.915	9.835
			Errors:	0.0002	1.174	22.954

Fig. 7 showing the results for multiple profiles

2: Measure Moments and Optical Depths

This option is identical to the previous one, except in that example it creates an additional file test.TAU as well as test.DTL. Also, it plots the optical depths immediately after it displays the results of the moments (i.e. Figures 6 or 7). The optical depths associated with Figure 6 are shown in Figure 8.

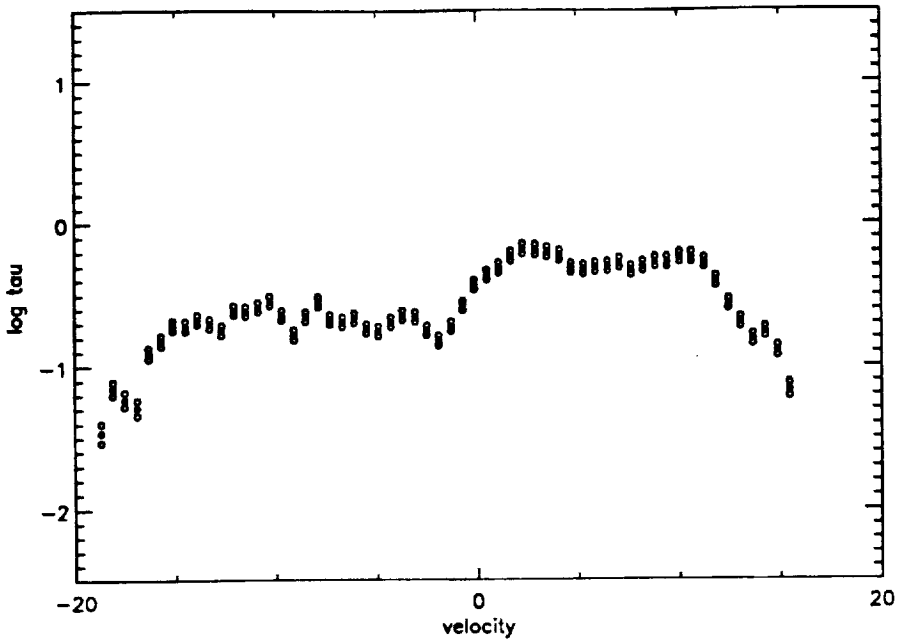


Fig. 8 showing the optical depths across the profile

The uncertainties, pictured in Figure 8 by open circles, only represent the systematic errors due to the uncertainties in the background and continuum placements. These data can be accessed later in Option 5: as profiles of the column density.

3: Manipulate Tabled Data

This portion of MSLAP enables the user to make customized tables of the measurements that were made in options 1: and 2: of the FIRST MENU. The investigator loads the "dtl" data structure by reading the .DTL file that was defined in option 1: or 2: of the FIRST MENU. He then can print an abreviated form of this dtl structure, create a ASCII format table of only the entries of interest, or has several sorting options, including reordering by Laboratory Wavelengths, by Observed Wavelengths, or by ION.

The working text window should be expanded to include the entire screen in this portion of MSLAP. The table creation is designed to handle large tables and the full-screen window prevents text from rapping around, making it difficult to read.

The routine is very generalized. Values supplied by standard MSLAP as well as those in the UserParameter (up) can be accessed and displayed in any order. Data from more than one file can be combined into one master table. Measurements that are absent in one file, but present in another, are supplied with epsillons in the master table. However, all files that are to be combined must be sorted in the same fashion.

Option 5 (to create a customized table in ASCII format) is particularly powerful. It allows the user to build the table, taking any number of pieces in any order and add these to an existing 2-dimensional character string. Parts of several data files can be included as well. Figure 9 shows the initial table at the start of Option 5. A small (the first 6 lines) portion of the table is shown at the top, while a list of options for adding to this 2-dimensional character

field is provided at the bottom. Initially only the species identifications, the wavelengths, and the oscillator strengths are included. A scale is provided immediately below the partial table to assist with the addition and deletion of columns of individual characters. The researcher then adds to, or subtracts from this 2-dimensional character field, using options 1 through 11.

```
>>>>>>>>>>>>>>>>>>>>>>>  Partial Display of the TABLE  <<<<<<<<<<<<<<<<<<<<<<<<

                                        test_____

Species         Wavelength     f
-------------------------------------
Fe II    .......  1125.44    0.0110
Fe II    .......  1125.44    0.0110
Fe II    .......  1125.44    0.0110
CN R(0)  .......  3874.61    0.0338
CN R(0)  .......  3874.61    0.0338
CN R(0)  .......  3874.61    0.0338
|.........:.........|.........:.........|.........:.........|.........:.........|.........:.........|.........:.........|
01234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890


>>>>>>>>>>>>>>>>>>>>>>>  CUSTOMIZED TABLE WORK SPACE  <<<<<<<<<<<<<<<<<<<<<<<<
First three columns include species name, lab. wavelength, and oscillator strength.
Total number of characters used is:      36 out of 120 max.
Total number of lines in the table:          14
Options for Adding/Subtracting to/from table are:

     1) Get new .DTL file
     2) Delete character columns
     3) Add Observed Wavelengths of current .DTL file
     4) Add Equivalent widths of current .DTL file
     5) Add Equivalent width ERRORs of current .DTL file
     6) Add 1st moments (DOPPLER VELOCITIES) of current .DTL file
     7) Add 1st moment ERRORs of current .DTL file
     8) Add 2nd moments of current .DTL file
     9) Add 2nd moment ERRORs of current .DTL file
    10) Add comment field  (Requires 10 characters)
    11) Add One of the UPs (UserParameters)
    12) Finish - Create file

Enter Option Number
```

Figure 9 showing the screen at the start of the creation of a customized table.

```
>>>>>>>>>>>>>>>>>>>>>>>  Partial Display of the TABLE  <<<<<<<<<<<<<<<<<<<<<<<<

                                        test
Species          Wavelength     f          EQW (A)     ME (A)    1st MOM.    ERROR     2nd MOM.    ERROR
-------------------------------------------------------------------------------------------------------
Fe II    .......   1125.44    0.0110       0.0275      0.0013      -1.37      0.50       69.712     5.683
Fe II    .......   1125.44    0.0110       0.0281      0.0012      -1.57      0.43       71.288     4.856
Fe II    .......   1125.44    0.0110       0.0262      0.0012      -1.43      0.47       68.753     5.281
CN R(0)  .......   3874.61    0.0338       0.0076      0.0002       0.51      0.47       13.723    12.357
CN R(0)  .......   3874.61    0.0338       0.0076      0.0002       0.51      0.47       13.723    12.357
CN R(0)  .......   3874.61    0.0338       0.0077      0.0002       0.34      0.55       15.469    16.462
|.....:.....|.....:.....|.....:.....|.....:.....|.....:.....|.....:.....|.....:.....|.....:.....|
012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890

>>>>>>>>>>>>>>>>>>>>>>>  CUSTOMIZED TABLE WORK SPACE  <<<<<<<<<<<<<<<<<<<<<<<<
First three columns include species name, lab. wavelength, and oscillator strength.
Total number of characters used is:      36 out of 120 max.
Total number of lines in the table:          14
Options for Adding/Subtracting to/from table are:

     1) Get new .DTL file
     2) Delete character columns
     3) Add Observed Wavelengths of current .DTL file
     4) Add Equivalent widths of current .DTL file
     5) Add Equivalent width ERRORs of current .DTL file
     6) Add 1st moments (DOPPLER VELOCITIES) of current .DTL file
     7) Add 1st moment ERRORs of current .DTL file
     8) Add 2nd moments of current .DTL file
     9) Add 2nd moment ERRORs of current .DTL file
    10) Add comment field  (Requires 10 characters)
    11) Add One of the UPs (UserParameters)
    12) Finish - Create file

Enter Option Number
```

Figure 10 same as Figure 9, except additional columns of data have been added.

Figure 10 shows the development as the result of sequentially invoking options 4, 5, 6, 7, 8, and 9. Notice that an underline starting with the file name "test" extends to the right over all of this data. Once data from a new file is added the name changes and a new under line will continue from that point. Two data sets that have been combined from files: test2 and test3 as shown below. Notice that some minor editing of the file (such as the creation of true ellipses) is required.

				test2		test3	
Species		Wavelength	f	EQW (A)	ME (A)	EQW (A)	ME (A)
Fe II	.....	1125.44	0.0110	0.0275	0.0013	0.0275	0.0013
Fe II	.....	1125.44	0.0110	0.0281	0.0012	0.0281	0.0012
Fe II	.....	1125.44	0.0110	.....		0.0262	0.0012
CN R(0)	.....	3874.61	0.0338	0.0076	0.0002	0.0076	0.0002
CN R(0)	.....	3874.61	0.0338	0.0169	0.0009	0.0076	0.0002
CN R(0)	.....	3874.61	0.0338	.....		0.0077	0.0002
CN R(0)	.....	3874.61	0.0338	.....		0.0077	0.0002
CN R(0)	.....	3874.61	0.0338	.....		0.0169	0.0009
CN R(0)	.....	3874.61	0.0338	.....		0.0879	0.0227
CN R(0)	.....	3874.61	0.0338	.....		0.1160	0.0413
CN R(0)	.....	3874.61	0.0338	.....		0.0076	0.0002
CN R(1)	.....	3874.00	0.0228	0.0021	0.0002	0.0020	0.0002
CN R(1)	.....	3874.00	0.0228	0.0020	0.0003	0.0020	0.0002
CN R(1)	.....	3874.00	0.0228	0.0020	0.0002	0.0020	0.0002

4: Edit Tabled Data

This portion of MSLAP allows the user to perform basic editing functions on the dtl data structure. The routine is modeled after primitive line editors that were common in the days of the PDP-11 computers. Single key strokes control the editing functions. The user can move up or down by one line, move to the top or bottom of the data structure, insert or delete a line, or change a line. A line is defined currently as a complete set of measurements for a single profile, including any comments and any values in the user parameter. A small window is opened on the right side of the screen and a complete list of the functions is printed as a reminder to the user.

The changes become permanent if the users updates the file on disk. Otherwise, the researcher may Kill/Quit the session at any time without making any additional changes since the last time the disk file was updated.

When the option to changes the values in a single "line" is used (i.e. pressing a "c"), all values are defaulted to the existing values before entering this mode. In this manner, the investigator

only has to strike the ¡return¿ key repeatedly until he reaches the value(s) to be changed. This feature reduces the probability that typographical errors will be introduced while attempting to make minor changes.

5: Analyze Column Densities vs Velocity

In this portion of MSLAP, the investigator cycles through a series of MENUs over the plot window. The MENUs are ordered in the following hierarchical sequence to determine: 1) what to do next, 2) the species, 3) which profile (identified by wavelength), and 4) plotting symbol or style. After each profile has been plotted the researcher can then get additional profiles or make adjustments to the one just plotted. Figure 11 shows an example of the Fe II column density as a function of velocity for several profiles.

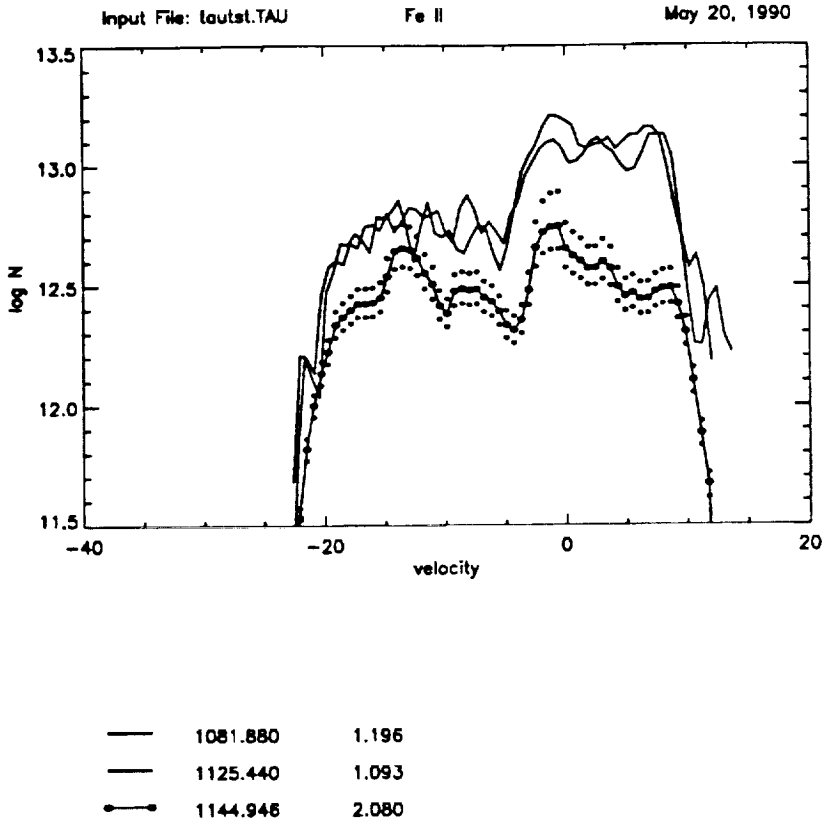
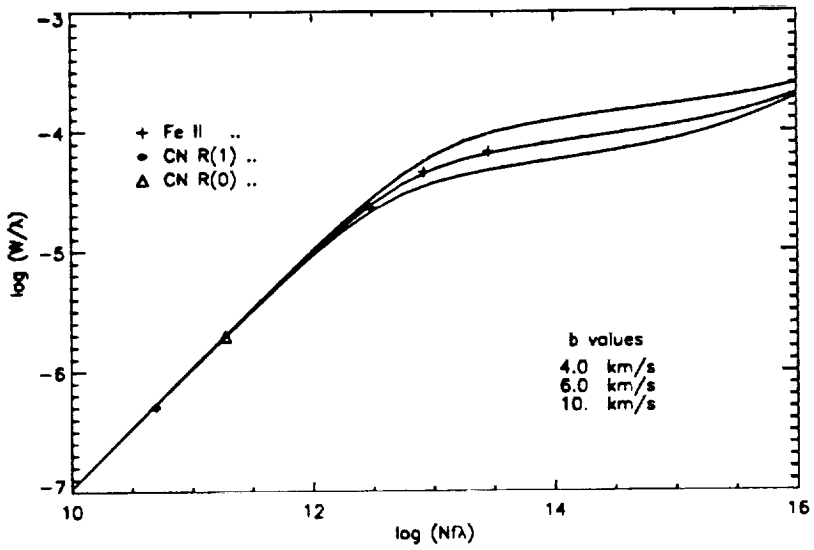


Fig. 11 showing the output from option 5:

Figure 11 shows the column-density results of two weaker profiles of Fe II, which are in good agreement with each other, plotted as continuous lines. The other over plot (solid line with dots) is for an intrinsically stronger absorption line. The disagreement indicates the presence of narrow, unresolved, saturated structure. Figure 11, also showing two of the different plot options, has error dots above and below for the strong line. A key of the plot symbols is provided at the bottom of Figure 11, showing the wavelength and log($f\lambda$) values.

6: Compare Data to Curve of Growth

The Curve of Growth routine is very similar to the one to analyze column densities as a function of velocity. The investigator configures the plotting through a series of MENUs that appear over the plot window. The first species to be plotted is selected, its plotting symbol, and the number of theoretical curves. All of these can be changed dynamically at any time to assemble a figure as shown in Figure 12. The software then presents the data and the investigator moves these data points horizontally by using the cursor to note starting and ending positions. Once satisfied with the fit, the researcher can then get additional data points to fit, or has a host of other options by using the right mouse button.



Obs. data from file: test.DTL May 20, 1990
Theo. COG: O I 1302.169 F=0.0486 GAMMA=5.72E08 0.0 5 3 1.801

log N(CN R(0) ..) = 10.9610
log N(CN R(1) ..) = 10.5549
log N(Fe II ..) = 13.1810

Fig. 12 showing the output of the Curve of Growth

IV. Comments on Correct Statistical Techniques

The subject of Correct Statistical Techniques is one that requires numerous pages to be complete. Unfortunately, time pressures on the author do not permit an adequate treatment in the current volume. It is hoped that future updates of the MSLAP Documentation will contain substantially more topics and details on the various aspects of using good statistical techniques as they apply to the MSLAP analysis package. There are several issues, however, that must be stated, even if only briefly.

1) Getting a good fit of the continuum is particularly important. The uncertainties in all of the measurements are determined from the residuals of the real data minus the fitted continuum for each point in fitting region. If there is a systematic error produced over some

portion of the spectra, this may manifest itself in the form of unrealistically large values of the random uncertainties. To avoid this difficulty, one might be tempted always to fit with a polynomial of the highest order available on the assumption that such a fit should be equal to, or better than that from a lower order polynomial. However, such action is not without risk. If a polynomial with too high of an order number is selected, the continuum fit occasionally may be ill behaved, especially over the regions where it is not constrained. In other words, the fitted continuum may not represent the real continuum at precisely those wavelengths where it is needed most, over the absorption profile. The author did not have to search very far through his own data to see several examples of this problem. Figure 13 shows a first (solid line) and fifth (dashed line) order fit to the same Fe II profile. The first order fit is the appropriate choice based on the F Distribution Tests for selecting polynomials of various order. The first, second, third, and fourth order fits are almost indistinguishable from each other. If one were blindly to use the highest (5th) order available, the equivalent width would be over estimated by more than 1 sigma of the best estimate. Other profiles exhibited far less dramatic continuum shapes, but just as severe differences in the measured values.

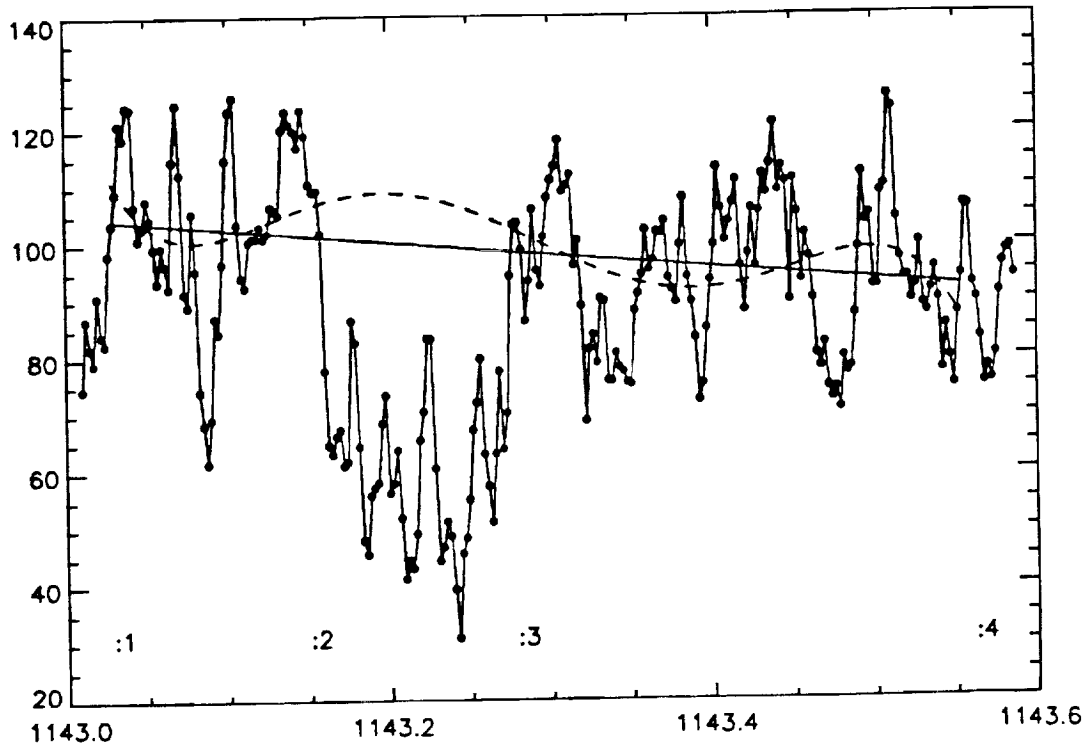


Fig. 13 showing different polynomial fits.

2) In MSLAP, the user specifies which regions of the spectra that he believes to be free of any spectral feature for the purposes of performing a continuum fit. The subjective responses of the researcher can make it very easy for him to avoid preferentially any 2-, or 3-sigma, deviations in choosing these regions. This action, of course, skews the uncertainty calculations towards smaller errors. While 3-sigma events are uncommon, these still have an impact on the total uncertainty since the contribution to the sum from each data point is quadratic in nature.

3) In the standard integrating program, the user specifies the starting and stopping points. As with issue 2, there is a human temptation capable of introducing systematic errors. In the

case of absorption features, many researchers choose the end points of the integration to be the places where the spectrum crosses the fitted continuum closest to the center of the profile. This action leads to a predictable, systematic over estimation of the equivalent widths and second moments (Joseph 1989, PASP, 101, 623).

4) There are a number of common oversights. For example, the background uncertainty in many applications is the dominant source of error, but it is often completely ignored by the investigator. Likewise, the researcher needs to pay attention to the coherence length of the noise. The easiest way to visualize this coherence length is to consider first a spectra produced by an instrument in which each pixel is totally linearly independent of all the others. These data would then have a coherence length of unity. If, instead, the value in each pixel in the instrument was equally dependent on the values of its adjacent pixels on either side, or if the previous data have been smoothed by a 3-point running boxcar, then the coherence length would be 3. For various reasons of data handling and instrumental affects, most data to be analyzed usually have a coherence factor greater than unity.

V. Customizing MSLAP

MSLAP makes use of a IDL feature where subsequent calls to compile a routine with an identical name overlays the previous. The routines have been organized into several files in part according to the frequency in which each is expected to be modified. This organization is an attempt to minimize the amount of code the typical researcher has to wade through in order to make his desired changes. For example, 90% of all alterations are expected to occur in the file mslap.pro, containing less than 350 lines of code compared to the more than 4,000 lines for the entire MSLAP package. All source code is listed in Appendix A, including a table of contents with brief description of each routine.

As already stated, most modifications to MSLAP are expected to be implemented inside mslap.pro. Before running MSLAP, each user copies the mslap.pro file to his own directory. This file contains a number of dummy programs that have been commented out, but with instructions showing how to install altered forms of these routines. Thus, many investigators can have their own customized version of MSLAP without having to keep a complete copy of all of the source code. In fact, occasionally a researcher will have two or more customized forms of MSLAP in his account.

The rest of this section is divided into several specific applications. First, a detailed description of the mslap.pro file is given. Next, the data-getting routines and the file dgets.pro is presented. Finally, the structure and use of the Look Up Tables is discussed.

a. The mslap.pro File

The file mslap.pro contains many useful dummy programs that have been broken out of the main software package. Some of these are real dummy programs, allowing the user to customize MSLAP merely by inserting a few lines of code, while others are actually comment fields for the purpose of being able to overlay different individualize routines. In addition, there is a routine at the beginning of mslap.pro called: usermenu, which provides the character strings used to print the primary MENU of options found above the graphic plot when

the right mouse button is pressed. This MENU is the principle means of branching once the main portion of MSLAP is running. Occasionally, a researcher will develop a mental block regarding the meaning of a question or menu option, which can be especially problematic if the investigator uses the software infrequently. In these cases, the user is invited to modify these character strings to make them more meaningful. The functionality, however, is defined elsewhere and remains unchanged.

There are 3 dummy routines, userprog1, userprog2, and userprog5, reserved for the user to create specialize programs. These routines are accessed during the execution of MSLAP by first pressing the right mouse button and then selecting the appropriate menu option. Userprog1 and 2, either of which can be executed from Options 1: or 2: in the FIRST MENU, are particularly useful in cases where the set of calculations are not always performed. If a set of specialized calculations is to be performed each time a profile is measured then auto_int_sav may be the more appropriate dummy routine to use. The latter is called every time the various moments of the profile are calculated. In a similar fashion, userprog5 is used for inserting customized calculations during the portion of MSLAP that analyzes the Optical Depths/Column Densities (Option 5: of the FIRST MENU).

Furthermore, there are 2 routines, plotlab1 and plotlab2, that are automatically called during the plotting of spectra and expanded spectra, respectively. These routines can be used, for example, to place additional labels on the plots.

b. The dgets.pro File

There are 5 slots available in MSLAP for the data-getting routines used to read the files containing the input spectra. These routines, called dget1, dget2, ..., dget5, are formally outside of MSLAP, and therefore, are the sole responsibility of the user to write or obtain from some other source. DGET routines for various data sets, however, are being written all the time and these contributions will be continually added to the library. While MSLAP only supports up to 5 dget routines at any one time, each investigator chooses the 5 that best meets his needs.

These files are "linked" into MSLAP by issuing indirect compile statements in the mslap.pro file. For instance, the syntax to compile the dget2.pro file is: "@dget2.pro". The user need only include as many (5 max.) dget routines as he needs. For convenience, a file called dgets.pro, containing 5 sample dget routines in a single file, has been included in the library. An indirect compile statement of this file avoids including 5 similar statements in mslap.pro and minimizes the number of file names in the researcher's directory.

To install a dget routine, the user must place the indirect compile statement in mslap.pro as already mentioned and must include the following statements at the beginning of the program:

```
if mp.dget eq 0 then begin
   mp.dget = 1
   return
end
```

These statements form the mechanism that MSLAP uses to sense that a valid dget routine is present and supercedes the dummy one that is otherwised supplied. As an added feature, the string variable called "ID" can be set to a brief, descriptive text, indicating the nature of the routine. This variable will also appear as part of the print-out of available data-getting

routines. For example, adding the line:

```
ID = '**** This is my favorite routine ****'
```

to dget5.pro just after the procedure definition statement will produce the following entry during the set up phase of MSLAP:

```
------------------------------------------------------------
DATAGET Options:

     1) IUE Standard GO Files for High-Res. Spectra (DISKGET)
     2) NOT Being Used
     3) ASCII Format of Wavelength-Spectra-Quality-BG
     4) 1024-Element Stand-Alone Data
     5) **** This is my favorite routine ****
------------------------------------------------------------

Which one would you like ?
```

Finally, the user should place in the parameter mp.FNAM, the file name being opened by the dget routine. MSLAP displays this parameter as the input data source above some plots. Other features include: mp.order, mp.CAM, mp.bg, and mp.bgerr, which indicate echelle order number, the camera number, the background level, and the error in the background level, respectively. Note: all parameters in the three main data structures are global in nature and thus, can be accessed from any routine. See Appendix B for a complete listing along with descriptions of functionality.

c. Look Up Tables

MSLAP creates a file called ulut.tab in the working directory of the investigator when he first requests to store an species that he has identified. If this file exists, MSLAP searches it for close matches every time an identification is requested. MSLAP defines a close match as being within 10 pixels or 0.1 Å which ever is smallest. The value of the search agreement can be selected by setting: mcntrl.wtol. Note: removing the file ulut.tab destroys all user-ID entries.

Software exists to convert any look up table that may exist in ASCII format into one that can be used by MSLAP. For the time being, interested parties should contact the first author regarding this utility.

VI. Installing MSLAP (for the system manager)

Obviously, the location of the software and tabled information can be organized in a number of ways. The present discussion, however, will only describe the simplest method of installing MSLAP. Note that MSLAP is written in the IDL language and must run on a workstation

supporting IDL.

First select or create a directory to hold the MSLAP programs and change to that directory. The entire package requires about 500 kilobytes of space. Next create a subdirectory called "tabdata" to hold the tabled information. Standard MSLAP expects the look-up tables to be located in a subdirectory of the directory holding the programs. All files containing tabled data have a ".tab" extension. The rest of the files should be placed in the parent directory. Make sure that all of the files have read-only permission. IDL programs are always compiled in real time from the source code. Thus, it is unnecessary for individual users to have either execute or write permission.

Edit the files: main.mslap, master.aux, and mslap.pro so that all occurrences of the string sequence: /u/clj/mslapdir are replaced with a string sequence appropriate for the path to the parent directory holding the MSLAP software. The new string should be sufficiently complete that users can access this directory from any directory where they store their programs and data. Note: be sure to keep the "@" symbol since this is a linking or call to compile command.

Turn to the section on Getting Ready (§II of this Manual) and write in the directory path where you have just installed the MSLAP software. Users will want to copy the mlsap.pro file from this directory.

All plot commands that are hardware specific are located in a single file called plotconfig.pro. In standard MSLAP, this file is designed to handle automatically either sunview or X windows and to open one of several types of graphical or text windows, each with a specific location and size. Some minor adjustments to the values specifying size and location, therefore, may be necessary from one machine to another. The plotconfig.pro program also configures the hardware so that IDL plot commands produce PostScript plot files, which serve as hard copies of graphical output appearing at the console. The user of MSLAP can request that these "plots" be sent to the laser printer from inside MSLAP. If the default laser printer is not a PostScript printer, the line of code with the command:

spawn,'lpr temp.ps'

must be changed so that "lpr" is changed to "lpr -P[name]", where name is the device supporting PostScript. If your computer supports another device such as Hewlett-Packard Graphics Language (HP-GL) which IDL is equipped to handle, then you will need to consult the IDL manual for the appropriate commands to substitute in plotconfig.pro. Only the code inside plotconfig.pro needs to be altered, however. If you do not have a hard copy unit that IDL recognizes then you should comment out those portions of plotconfig.pro. Note: the appearance of a semicolon causes IDL to consider the remainder of that line to be a comment field.

The file dgets.pro contains a set of 5 data-getting routines, all of which are formally outside of MSLAP. Actually, it is the responsibility of the researcher using MSLAP to write or substitute as necessary various dget routines so that his data can be read into MSLAP. However, if you represent a guest-user facility, you may wish to substitute several dget routines with ones that are suitable for your specific data formats. The new combination can either replace the dgets.pro file or an alternative file can be generated. Then a guest user can simply copy one of these files to his own directory and run MSLAP with minimal amount of effort to get started.

Finally a word of caution. MSLAP is designed so that customized routines can be inserted with minimal difficulty. The way that this is accomplished is to make use of a feature of IDL

where a subsequent compilation of a routine with the same name overlays the previous. A number of dummy routines exist as place holders in the event that no user-written programs are supplied. One may be tempted to consolidate the use of indirect compilation calls (e.g. the use of @program_name), but this may eliminate the modularity of MSLAP. The sequence of compilations is important and you should be careful not to change this order inadvertently.

VII. Trouble Shooting

The most common problem faced by the user of MSLAP appears to be either the failure to register a cursor reading or the registering of multiple readings from a single stroke of the mouse. For this reason, MSLAP normally attempts to reward the investigator with some type of output every time that he inputs a cursor location. The continuum fitting routine can be the most problematic since many cursor locations are read to set the intervals to be used for the polynomial fit. During this activity, the routine marks each selection with a colon ":" and a number beside it. The regions to be fit, thus, are from 1 to 2, 3 to 4, 5 to 6, and so on. The researcher is encouraged to monitor these numbers while selecting the ranges. If two numbers are superimposed or if one is missed, the continuum fitting routine should be started again. If improper registering of cursor readings becomes severe, then IDL "WAIT" statements will have to be included.

The data-getting routines (dget1, dget2, ..., dget5) are formally outside of MSLAP. Some unexpected behavior in MSLAP can occur if these routines do not make use of all of the required variables in the MSLAP-Parameter (mp) structure. For example, when the user requests new data in MSLAP, the software goes to one of the dgets provided by the researcher. That dget routine could solicit a new file name and read new spectra, but not place the updated file name in the mp.FNAM parameter. Then subsequent plots will not reflect the true input file name. Note that in some applications such as echelle data, it is desirable to configure the dget routine so that subsequent calls to dget return spectra from the next order and not open a new file. For other types of data, it is more natural to have a single spectrum for each file. Hence, the responsibility to return the necessary parameters to MSLAP has been left to the user. (See the section on the dgets.pro file.)

APPENDIX A - The Source Code

```
;
;
; ************************************************************************
;                  Modular Spectral Line Analysis Program
;            M.S.L.A.P.  version 1.0
;
;     copyright (c) 1991  by Charles L. Joseph and Edward B. Jenkins
;        All rights reserved.  A license may be obtained from the
;         first author or from an authorized distribution center.
;
;    This software has been distributed through the GHRS Data Center.
; ************************************************************************
;
;
;                THE FOLLOWING OPTIONS ARE AVAILABLE:
;
;
;              1:    Measure Profile Moments Only
;                       (Equivalent Width, Profile Centroid, etc.)
;              2:    Measure Moments and Optical Depths
;              3:    Manipulate Tabled Data
;              4:    Edit Tabled Data
;              5:    Analyze Column Densities vs Velocity
;                       on Option #2 Data
;              6:    Compare Data to Curve of Growth
;             10:    TO EXIT FROM THIS PROGRAM
;
;
; ------------------------------------------------------------------------
;
;    COPYRIGHT (c) 1984,  by Charles L. Joseph
;    COPYRIGHT (c) 1991,  by  Charles L. Joseph & Edward B. Jenkins
;
;
;    Released: 01-February-1991
;    Alteration History:  None since release date.
;
;
; ------------------------------------------------------------------------
;
;
;
;
PRO DETAILS,sff,timedate,libr,up
;******************************  DETAILS.PRO  ******************************
;
;   To control the measurement of equivalent widths or integrated fluxes
;                BY CHARLES L. JOSEPH   09-SEPT-80    11-MAY-90
;
;     sff       0 => Do not do Optical Depths  1 => Do Optical Depths (TAU)
;     timedate  Variable containing just the date.
;     up        UserParameter - 30 element floating vector, which is global.
```

```
;                    up is reserved for the exclusive use by the user.
;
;*****************************************************************************

;  Set up data structures  -- "mp" => MSLAP Parameter   "dtl" => for .DTL files

mp = { MSLAP, dget: 0, cntrl: -1, order: 0, CAM: 0, SMO: 0, cohfac: 0., bg: 0.,$
   bgerr: 0.0, window: 0.0, DTY: 0, STAR: ' ', FNAM: ' ', poly: 0, SNR: 0. }
mcntrl = { MSLAPc, I: 0, date: '', intopt: 1, MNE: 0, ESAV: 0.0, e0: 0., e1: 0.,$
   wtol: 0., e2: 0., libr: '', mtot: 5, f1n: 0., f2n: 0., fdist: fltarr(3,18) }

   fdist = [0.,1.,2.,3.,4.,5.,6.,7.,8.,9.,10.,15.,25.,50.,100.,500.,1000.,10000.]
   mcntrl.fdist(0,*) = fdist
   fdist = [161.,161.,18.51,10.13,7.71,6.61,5.99,5.59,5.32,5.12,4.96,4.54, $
    4.24,4.03,3.94,3.86,3.85,3.84]
   mcntrl.fdist(1,*) = fdist
   fdist = [200.,200.,19.00,9.55,6.94,5.79,5.14,4.74,4.46,4.26,4.10,3.68,  $
    3.38,3.18,3.09,3.02,3.00,2.99]
   mcntrl.fdist(2,*) = fdist

   mcntrl.date = timedate
   mcntrl.libr = libr

nulld = { noda, el: bytarr(15), iaf: long(0), wl: 0., f: 0., owl: 0., eqw: 0., $
   me: 0., fm: 0., fme: 0., sm: 0., sme: 0., com: bytarr(10), up: fltarr(30) }
   dtl = replicate({ noda }, 200)                    ; Make array for storage
   sdata = nulld                                     ; Make working copy
   mdata = replicate({ noda }, 4)                    ; and for multiple meas.
   COMS = '...'                                      ; Make dummy comment

   SETUP,ML,RS,FF,dtl,nulld,nside,mp,mcntrl,up       ; Set everything up &

NEXT: dataget,WA,SPECT,JJ,IHDR,FF,mp,mcntrl,up       ; Get next spectrum.
     IF mp.cntrl eq -99 THEN goto,FINISH             ; How to get out.
     WW = 0.0
     !x.range = [ 0., 0. ]                           ; Set for AUTO Scaling.
     !y.range = [ 0., 0. ]

IT:  GRAPHS,SPECT,WA,IHDR,JJ,mp,mcntrl,up            ; Plot routine
     mp.cntrl = 1                                    ; Reset CNTRL flag
     mdata = replicate({ noda }, 4)                  ; Reset multiple meas.
     print,' '
     print,'Left Mouse to Locate Feature to be Measured -- Need NOT be centered'
     print,'Middle Mouse to GO ON, get new data'
     print,'Right Mouse to bring up UserMenu of other options.'
                                                     ;
MORE: TVCRS,0.5,0.5,/NORMAL                          ; Set action to graph.
      ucursor,IX,IY,opt,iopt,0,mp                    ; Get graphical input &
; control options.


;  >>>>>>>>>>>>>>>>  Master Branching Section  <<<<<<<<<<<<<<<<<<<<<<<<<
```

```
     IF opt eq 9 THEN begin & STOP & goto, MORE & end   ; Stop for keybrd input.
     IF (opt eq 6) OR (!ERR EQ 2) THEN GOTO, NEXT       ; Next spectrum to plot.
     IF opt eq 3 THEN BEGIN                             ; Delete last measurement
I = mcntrl.I
dtl(I) = nulld
        PRINT,'  Line ',I,'  has been DELETED! ',STRING(7B) ; Print notice.
        mcntrl.I=mcntrl.I-1                             ; Set I to over write.
        IF mcntrl.I LT 0 THEN mcntrl.I=0                ; Can't go negative.
     ENDIF                                              ;
     IF opt eq 4 then begin                             ; Comments?
   sdata = dtl(mcntrl.I-1)                          ; Get info on last meas.
   read,COMS                                        ; Read comment.
   sdata.com = byte(string(COMS,format='(a10)'));Put it into byte array.
   dtl(mcntrl.I-1) = sdata                          ; Update master data set
   sdata = nulld                                    ; Set existing to null.
   goto, Storit
     endif
     IF opt eq 2 THEN GOTO, FINISH                      ; End session option
     if opt le 4 then goto, MORE                        ; Rem.,Del.,Nothing
     if opt eq 7 then begin                             ; Call User Prog. #1.
    print,' '                                       ; Just to flush cursor.
    usrprog1,WA,SPECT,JJ,mp,up                      ;
    endif
     if opt eq 8 then begin                             ; Call User Prog. #2.
    print,' '                                       ; Just to flush cursor.
    usrprog2,WA,SPECT,JJ,mp,up
    endif
     if (opt eq 7) OR (opt eq 8) then goto, IT          ; UserProgram called.
     if opt eq 5 then begin mp.cntrl = -10 & goto,IT & endif ; Make hardcopy.
     if (opt eq 11) OR (opt eq 12) then goto, IT        ; Adjustments only.

; >>>>>>>>>>>>>>>>>  End Master Branching Section  <<<<<<<<<<<<<<<<<<<<<<<<

;
;  ---------------  Begin Normal Flow of Routines  ----------------------
;  ---------------   "The Guts of this Program"    ----------------------
;
MEAS:     WW= IX                                        ; Save wavelength.
     J=0                                               ; Set up & get closest
     J = TOTAL(WA LT WW)                               ;  index for EXPAND.PRO
     COMPARE,WW,RS,sdata,mp,mcntrl                     ; Get LUT entry.
     IF mp.cntrl eq 0 THEN GOTO,IT                     ; Not a good ID ?
     !x.range = [0.,0.]                                ; Reset to auto scaling
     !y.range = [0.,0.]                                ;    for the plots.
;                                                      ;
;                                                      ;
   EXPAND,SPECT,ESP,WA,EWA,JT,JE,J,nside               ; Data for expanded plot.
; Then, Fit a continuum.
   CONTIM,ESP,EWA,CNT,WA,JJ,XF,XI,JE,XLIMIT,mp,mcntrl,up,sdata,mdata, $
  nulld,RS,nside
   IF mp.cntrl eq 0 THEN begin                         ; Flag set to abort.
```

```
      !x.range = [0.,0.]                                    ; Reset to auto scaling
      !y.range = [0.,0.]                                    ;    for the plots.
      goto, IT
   endif
   IF mp.cntrl gt 2 THEN GOTO,NEXT                          ; Flag for next spectrum.
   TAU = fltarr(6,8)+100.                                   ; Make dummy just in case
   INTGRT,ESP,EWA,CNT,TAU,JE,XF,XI,XLIMIT,mdata,mp,mcntrl,up  ; Calls EQUIV.PRO &
      ; plots results.
     !x.range = [0.,0.]                                     ; Reset to auto scaling
     !y.range = [0.,0.]                                     ;    for the plots.
;                                                           ;
Storit: IF mp.cntrl eq 1 THEN STORE,WW,ML,dtl,mdata,mp,mcntrl,up ; Store .DTL
   if (mp.cntrl eq 1) and (sff eq 1) then begin             ; Optical depths too?
      fstore,TAU,sdata,mp,mcntrl,up                         ; If so, plot & store.
   endif
   IF (opt ne 2) AND (mp.cntrl ne -99) THEN GOTO, IT        ;  Do some more or go
;                                                           ;   back to MSLAP
FINISH: wdelete,0                                           ; Remove plot windows.
        wdelete,1                                           ; Remove plot windows.
        if sff eq 1 then close,5                            ; Close .TAU file.
close,1                                          ; Close .DTL file.
        openu,1,mp.STAR+'.DTL'                              ; Open again to catch
        writeu,1,dtl                                        ; any last minute changes
        close,1                                             ; Close .DTL file again.
;                                                           ;
RETURN                                                      ;
END ; DETAILS
;
;
;
PRO FLAGSET,FF,mp,up
;************************** FLAGSET.PRO ************************************
;
;     by Charles L. Joseph                          June 29, 1990
;
;     This procedure determines which look up table and data-getting
;     rountine are to be used.
;
;        FF          flag for which DGET routine to use
;        mp          MSLAPparmeter - a structure
;        up          UserParameter - 30 pt floating array
;
;*****************************************************************************
     DTY=1
DETR: for k = 0,3 do print,' '                              ; print lookup tables
     print,'-------------------------------------------------------------'
     print,'Available lookup tables are:'
     print,' '
     print,'     1)  Interstellar Lines  (Morton and Smith 1973 plus updates)'
     print,'     2)  Molecular Hydrogen, HD, and CO'
     print,'     3)  Options 1 & 2 Combined'
     print,'     4)  Hot-Star Lines'
```

```
     print,'-------------------------------------------------------------'
     for k=1,2 do print,' '
     READ,'Which one would you like ?',DTY              ; find out which one
     IF(DTY LT 1) OR ( DTY GT 4) THEN GOTO,DETR         ; no such table
     mp.DTY = DTY
RFL: up = fltarr(30)                                    ; define User-Param.
     iok = intarr(6)
     for k = 0,3 do print,' '
     print,'-------------------------------------------------------------'
     print,'DATAGET  Options:'
     print,' '
     mp.dget = 0                                        ; Sense which data-
     dget1,FNAM,w,spect,q,ihdr,ID,mp,up                 ; get routines are
     if mp.dget eq 1 then iok(1) = 1                    ; present and show
     print,'     1) ',ID                                ; options.
     mp.dget = 0
     dget2,FNAM,w,spect,q,ihdr,ID,mp,up                 ;
     if mp.dget eq 1 then iok(2) = 1
     print,'     2) ',ID
     mp.dget = 0
     dget3,FNAM,w,spect,q,ihdr,ID,mp,up
     if mp.dget eq 1 then iok(3) = 1
     print,'     3) ',ID
     mp.dget = 0
     dget4,FNAM,w,spect,q,ihdr,ID,mp,up
     if mp.dget eq 1 then iok(4) = 1
     print,'     4) ',ID
     mp.dget = 0
     dget5,FNAM,w,spect,q,ihdr,ID,mp,up
     if mp.dget eq 1 then iok(5) = 1
     print,'     5) ',ID
     print,'-------------------------------------------------------------'
     FF = total(iok)                                    ; How many valid progs?
     if FF eq 0 then begin                              ; If none, complain.
print,string(7B),'There are no valid data-getting routines loaded.'
print,'At least 1 valid routine must be put in the file: dgets.pro'
FF = ' '
read,'Press <Return> to exit',FF                ; Pause so user realizes
retall                                          ; the trouble & abort.
     endif
     for k=1,2 do print,' '
     READ,'Which one would you like ?',FF               ; Find out which one.
     if (FF lt 1) OR (FF gt 5) then goto,RFL            ; Valid Choice?
     if iok(FF) ne 1 then goto,RFL                      ;   Do this one exist?
     if iok(FF) eq 1 then mp.dget = 1                   ;   Insure flag is set.
RETURN                                                  ;
END
;
;
;
PRO GRAPHS,SPECT,WA,IHDR,JJ,mp,mcntrl,up
;******************************** GRAPHS.PRO ********************************
```

```
;
;       TO PLOT THE SPECTRUM.     By Charles L. Joseph   Sept. 1980  Nov, 1990
;
;       SPECT     flux vector
;       WA        wavelength vector
;       IHDER     header vector
;       INDEX     plot or replot status
;       JJ        data quality vector
;       FNAM      data file name
;       mcntrl    structure (see DETAILS.PRO)
;       mp        MSLAP structured variable: mp.cntrl = control flag
;                                            mp.order = order number
;                                            mp.cam   = camera number
;       up        UserParmeter - 30 pt floating array, exclusive for user.
;
;*****************************************************************************
;
  !y.margin(0) = 4.
  FNAM = mp.FNAM
  star = mp.STAR
  kwtd = 0                                              ; What-to-do HardCopy Flag.
  if mp.cntrl eq -10 then begin
     kwtd = wmenu(['Copy?','Yes','No'],title=0, init=2)
     if kwtd eq 1 then plotconfig,1,' ',' ',-1,kdev,'' ; Config for Hardopy.
  endif
  tl0 = 'Output: '+star+'              M.S.L.A.P.              Input: '+FNAM
  tl0 = tl0+'       '+mcntrl.date
  xxxs = fltarr(2)
  yyys = fltarr(2)
  sz = size(WA)
  jcnt = 1
  if sz(1) gt 16 then jcnt = fix(sz(1)/16)
  if mp.cntrl eq -1 then plotconfig,0,tl0,' ',1,kdev,'' ; Set up graphics device.
  ymn = min(SPECT,J5, MAX=ymx)                          ; Find min and max flux.
  if ymn gt 0 then ytst = ymn ELSE ytst = ymx           ; For bottom of plot use 0
  if ytst lt 0.75*ymx then ymn = 0.                     ;     unless featureless.
  xmx = max(WA,jmx, MIN=xmn)                            ; Min & max plus max(index)
  vmn = mp.bg - mp.bgerr - 0.1*(ymx-ymn)                ; Get min. needed for BG
  if ymn eq 0. and vmn gt 0 then ytst=1 ELSE ytst=0     ; Prevent double jeopardy?
  if ymn le vmn then vmn = ymn - 0.1*(ymx-ymn)          ; Less than min. spect?
  if ytst eq 1 then vmn = 0.                            ; Correct double jeopardy.
  ymx = 1.1*ymx                                         ; Adjust for more space.
  xxxs(0) = xmn   &   xxxs(1) = xmx                     ; Put limits into small
  yyys(0) = vmn   &   yyys(1) = ymx                     ;   over plot array &
  if !x.range(0) OR !x.range(1) OR !y.range(0) OR !y.range(1) then begin
     if !x.range(0) OR !x.range(1) then begin           ; Use these values instead?
xmn = !x.range(0)                                 ; If one is nonzero => user
xmx = !x.range(1)                                 ;    wants to over ride.
     endif
     if !y.range(0) OR !y.range(1) then begin           ; Use these values instead?
vmn = !y.range(0)
ymx = !y.range(1)
```

```
    endif
  endif
  plot,xxxs,yyys,/NODATA, xtitle='Wavelength (A)', ytitle='Rel. Flux', $
       xrange=[xmn,xmx],yrange=[vmn,ymx],xstyle=1,ystyle=1
  if mp.SMO then begin
     OPLOT,WA,SMOOTH(SPECT,3), $                          ; Plot smoothed flux.
          Xtitle='Wavelength Angstroms',Ytitle='Rel. Flux'
  endif else begin
     OPLOT,WA,SPECT, $                                    ; Plot unsmoothed flux.
          Xtitle='Wavelength Angstroms',Ytitle='Rel. Flux'
  endelse
  OPLOT,WA,JJ                                             ; Plot data quality.
  if (J5 gt jcnt) then xxxs(0) = WA(J5-jcnt) ELSE xxxs(0)=WA(0)  ;   BG range.
  if (J5 lt jmx-jcnt) then xxxs(1)=WA(J5+jcnt) ELSE xxxs(0)=WA(jmx)
  yyys(0:1) = mp.bg
  oplot,xxxs,yyys                                         ; Over plot BG.
  yyys(0:1) = mp.bg - mp.bgerr
  oplot,xxxs,yyys,linestyle=2                             ; Over plot BG-BGerror.
  yyys(0:1) = mp.bg + mp.bgerr
  oplot,xxxs,yyys,linestyle=2                             ; Over plot BG+BGerror.
  plotlab1,WA,SPECT,JJ,mp,mcntrl,up                       ; Customized labels.
  if mp.order gt 0 then PRINT,' Order'                    ; Print order # .
  if mp.order gt 0 then PRINT,mp.order                    ;
  if kwtd then begin
     xyouts,0.5,1.1,FNAM,/NORMAL                          ; Put file name on plot.
     plotconfig,-1,' ',' ',-1,kdev,''                     ; Send plot & -> term.
  endif
  IF mp.cam NE 0 THEN BEGIN                               ; Valid IUE CAM #?
        IF mp.cam LE 2 THEN PRINT,' long' ELSE PRINT,' short'
        END                                               ;
  mp.cntrl=1                                              ; Set to norm.
RETURN                                                    ; Go back
END                                                       ;
;
;
;
;
PRO SETUP,ML,RS,FF,dtl,nulld,nside,mp,mcntrl,up
;****************************  SETUP.PRO  ************************************
;
;       Gets or creates a new .DTL file as well as other set up information
;       for DETAILS.   by Charles L. Joseph      June 1981     May 1990.
;
;       ML          maximum number of measurements that can be made.
;       RS          Red Shift (Doppler velocity) used in LUT.
;       dtl         Structure that holds contents of .DTL file
;       nulld       A nulled or zero version of the variable dtl
;       nside       # of points on each side of the expanded plots - set to 60
;       mp          MSLAPparameter - a structure, used to pass many arguments.
;       mcntrl      structure (see DETAILS.PRO)
;       up          UserParmeter - 30 pt floating array, exclusive for user.
;
```

```
;
;*****************************************************************************
   ML=200                                                  ; max # of lines
   I=0                                                     ; set master index
   nside = 150                                             ; # of expansion points.
START: STAR=' '                                            ; name loop
   print,' '
   READ,'What is the output file name ?',STAR
   IF STAR EQ 'H' THEN BEGIN                               ; need help ?
      SPAWN,'ls *.DTL'                                     ; list old files
      GOTO,START                                           ; start again
   END                                                     ;
   PRINT,' '                                               ;
   close,1
   openr,1,STAR+'.DTL', ERROR = errtst                     ; Does file exists?
   close,1
   app = ' '                                               ; Set append flag to "NO"
   if errtst eq 0 then begin                               ; File Found ------------
      CLOSE,1
      OPENU,1,STAR+'.DTL'                                  ; Get the old file.
      ML=200                                               ; MAX meas. that can be made
      readu,1,dtl                                          ; Read the file.
      sz = where(dtl.iaf ne 0.)                            ; Get # of measurements.
      sz = size(sz)
      if (sz(0) eq 0) then I = 0 else I = sz(1)            ; If some made, set counter.
      close,1                                              ; Close file for now.
      print,string(7B),'File Already Exists'               ; Flash Screen and print.
      print,I,' measurements have already been made.'; Indicate # already made.
      print,' '
      print,'Append new data to the old?'                  ; Append or erase & start?
      read,'(Note: a NO will erase old data.)',app         ;
   endif

   if (app ne 'Y') AND (app ne 'y') then begin             ; If APPEND flag NOT set in
      close,1                                              ; "file exists" section.
      OPENW,1,STAR+'.DTL'                                  ; Make new file.
      dtl = replicate({ noda }, 200)                       ; Empty array for storage.
      writeu,1,dtl                                         ; Write it to file.
      CLOSE,1                                              ; Close until latter.
      I = 0
   endif
   print,' '
   print,'The radial velocity is used only to help identify species.'
   print,'Enter 0 if you are uncertain of the real value.'
   READ,'Enter Delta-Lambda/Lambda or Radial Velocity for the source: ',RS
   IF ABS(RS) LT 1.0E-02 THEN BEGIN                        ; assume D-l/l
      PRINT,'The Delta-Lambda/Lambda is: ',RS              ; tell assumption
   END   ELSE  BEGIN                                       ; else rad-vel
      PRINT,'The Radial Velocity is: ',RS,'  km/s'         ; say so
      RS=RS/299792.5                                       ; convert to D-l/l
   END                                                     ;
```

```
   FLAGSET,FF,mp,up                                    ; get data type
;                                                      ;
   CLOSE,1                                             ;
   mp.STAR = STAR
   mcntrl.I = I
EXIT: RETURN                                           ; go back to DETAILS
END                                                    ;
;
;
;
PRO CONTIM,EXSP,EXWA,CNT,WA,EPS,XF,XI,JE,XLIMIT,mp,mcntrl,up,sdata,mdata, $
   nulld,RS,nside
;***************************** CONTIM.PRO ***********************************
;
;       TO DETERMINE A CONTINUUM AND END POINTS FOR THE INTERGRATION
;       By Charles L. Joseph                          June, 1982
;       By Charles L. Joseph and Edward B. Jenkins    May 12, 1990
;
;       EXSP        expanded flux vector
;       EXWA        expanded wavelength vector
;       CNT         continuum vector
;       WA          wavelength vector
;       EPS         data quality vector
;       XF          right stop X value for integration
;       XI          left stop X value for integration
;       JE          index of the line center
;       XLIMIT      array containing start/stop to fit regions.
;       mp          MSLAPparameter - a structure, used to pass many arguments.
;       mcntrl      structure (see DETAILS.PRO)
;       up          UserParmeter - 30 pt floating array, exclusive for user.
;       sdata       structure containing a single dtl(k) element
;       mdata       same as sdata, but for 4 elements.
;       nulld       same as sdata, but all elements are set to 0
;       RS          red shift (Doppler velocity) for LUT
;       nside       the number of data points on each side of the expansion.
;
;*******************************************************************************
;
      mdata(0) = sdata
      m = 0                                            ; Set Null Polynom. Fit
      wmx = max(EXWA, jwmx, MIN=wmn)                   ; Find max & min lambdas.
START: imes = 0                                        ; # of descrete pts to fit.
      csav = 0                                         ; Do Not Overplot last CNT.
      cmes = fltarr(100,2)                             ; Holds cursor readings.
      kget = 0                                         ; Index and # for XLIMIT.
      iopt = 2                                         ; Cntrl option, UCURSOR.PRO
      AC = dblarr(9,10)                                ; For CURFIT.PRO
      BC = dblarr(16)                                  ; For CURFIT.PRO, fit para.
      bcsav = dblarr(10,16)                            ; To save various BC arrays
      XWRK = fltarr(602)                               ; Working wavelength vector
      YWRK = XWRK                                      ; Working flux vector.
      VSAV = XWRK                                      ; Temporary holding vector.
```

```
      CNT = 0.0*EXWA                                  ; Make empty continuum.
      XLIMIT = fltarr(30)                             ; Fitting end points.
      MM = intarr(9)                                  ; For CURFIT.PRO.
      COHFAC = 1.0
      sz = size(JE)                                   ; Find the # of line cntrs.
      if sz(0) eq 0 then lcs = 1 else lcs = sz(1)
      xxx = fltarr(lcs,2)                             ; Array for overplot cntrs.
      yyy = fltarr(2)                                 ; Array for overplot cntrs.
      yyy(1) = !y.crange(1)                           ; Set values for top to
      yyy(0) = !y.crange(0)                           ;     bottom over plots.
      yhalf  = 0.5*(yyy(1)-yyy(0)) + yyy(0)           ; For cursor positioning.
      fdsav = fltarr(2,mcntrl.mtot+1)

      kdev = getenv('TERM')                           ; X Window or Sunview?
      if kdev ne 'sun' then kdev = 'xterm'            ;

;  ----- Plot the spectrum, either smoothed or not --------------------------

   IF mp.SMO ne 0 then PLOT,EXWA,SMOOTH(EXSP,7),/YNOZ
   if mp.SMO eq 0 then begin
      ymn = min(EXSP,J5, MAX=ymx)                     ; Find min and max flux.
      xmx = max(EXWA,jmx, MIN=xmn)                    ; Min & max plus max(index)
      ymn = ymn - 0.1*(ymx-ymn)                       ; Adjust for plotting.
      ymx = 1.1*ymx
      if !x.range(0) OR !x.range(1) OR !y.range(0) OR !y.range(1) then begin
         if !x.range(0) OR !x.range(1) then begin     ; Use these values instead?
    xmn = !x.range(0)                          ; If one is nonzero => user
    xmx = !x.range(1)                          ;    wants to over ride.
         endif
         if !y.range(0) OR !y.range(1) then begin     ; Use these values instead?
    ymn = !y.range(0)
    ymx = !y.range(1)
         endif
      endif
      plot,exwa,exsp,/YNOZ,xrange=[xmn,xmx],yrange=[ymn,ymx],xstyle=1,ystyle=1
      asy = findgen(16)*(!PI*2/16.)
      usersym,0.5*cos(asy),0.5*sin(asy),/FILL
      oplot,exwa,exsp,psym=8                          ; Show individual points.
   endif
   OPLOT,WA,EPS<0                                     ; Plot data quality.
   for k=0,lcs-1 do begin                             ; If mult. profiles, then
       if lcs eq 1 then xxx(k,0:1) = EXWA(JE)         ; flag them on the plot.
       if lcs gt 1 then xxx(k,0:1) = EXWA(JE(k))
       oplot,xxx(k,0:1),yyy,linestyle=1               ; Use dotted line.
   endfor
   for k=0,3 do print,' '                             ; Let user know in CONTIM.
   print,'      >>>>>>> START of Continuum Fitting Routine <<<<<<<< '

 for kk=0,1000 do begin                               ; Do a large # of attempts.

      if (kk lt 1) then tvcrs,0.5,0.5,/NORMAL         ; 1st time?  Place cursors.
      if (iopt eq 2) then begin                       ; 1st time?  Instructions.
```

```
        print,' '
        print,'Left Mouse to locate END POINTS of featureless continuum segments'
print,'                    - Only horizonatal position will be used.'
print,'                    - Up to 15 segments are allowed.'
        print,'Right Mouse button provides additional MENU options.'
        print,'Click Center Mouse when finished.'
    endif
CHANGE:  ucursor,IX,IY,opt,iopt,1,mp                    ; Graphical input & contrl.
    if IX gt wmx then IX = EXWA(jwmx-1)                 ; Don't except out of range
    if IX lt wmn then IX = wmn                          ; Don't except out of range

;  ------------------  Branching in Continuum Routine --------------------

      if !ERR eq 2 then goto, calc                      ; Middle Mouse used in
      ;        UCURSOR.PRO.
      if !ERR eq 1 then begin                           ; Left Mouse used.
 XLIMIT(kget) = IX                                  ; Store Fitting Limits.
 kget = kget + 1                                    ; Update counter.
        yout = 0.07*(!y.crange(1)-!y.crange(0)) + !y.crange(0)
 xyouts,ix,yout,':'+strtrim(kget,2)                 ; Show the fitting limit.
      endif

     if iopt eq 2 then begin                            ; Define discrete
      ; continuum points.
        imes = 0
        plotconfig,0,' ',' ',3,kdev,''                  ; Open small instr. window.
        xout3 = !x.crange(0)
        yout = 0.5*(!y.crange(1)-!y.crange(0)) + !y.crange(0)
xyouts,xout3,yout,'Use Left Mouse - Continue until Middle Mouse'
wset,0                                              ; Control back to plot.
!ERR = 0
while (!ERR ne 2) AND (imes lt 100) do begin
   ucursor,ix,iy,opt,kchoice,0,mp
;          if kdev eq 'xterm' then wait,1
   if !ERR ne 2 then xyouts,ix,iy,'x'               ; Show discrete points.
          if !ERR ne 2 then cmes(imes,0) = ix        ; Update discrete param.
          if !ERR ne 2 then cmes(imes,1) = iy
          if !ERR ne 2 then imes = imes + 1          ; Update total number.
        endwhile
wdelete,3                                           ; Remove instruct. window.
wset,0                                              ; Make sure back to graph.
print,' ',string(7B)                                ; Bell and give instruct.
print,'>>>>  Resume finding regions of featureless continuum  <<<<<'
     endif

     if iopt eq 3 then begin    ; ------------------- ; Redefine line center(s).
print,' '
print,string(7B),'>>>>  Use LEFT Mouse to locate New Line Center <<<<'
print,'      NOTE: If the RIGHT Mouse is used first - then up to 3'
print,'            additional line centers can be defined.'
       yout = 0.5*(!y.crange(1)-!y.crange(0)) + !y.crange(0)
if lcs gt 1 then JE = JE(0)
```

```
        TVCRS,EXWA(JE),yout,/DATA
cursor,ix,iy
        if kdev eq 'xterm' then wait,1
xtst = !err                                  ; Temp. store key stroke.
!err = 0
vtmp = where(exwa ge ix)                     ; Get index of exwa cor-
JE = vtmp(0)                                 ; responding to input.
kk = 0
if xtst eq 4 then begin                      ; If RT. Mouse, do more.
   xxx(0:1) = ix                             ;
   oplot,xxx,yyy,linestyle=1                 ; Dotted line of new center
   vtmp = JE                                 ; Save JE to make JE(k).
   JE = intarr(4)                            ; Make JE into an array.
   JE(0) = vtmp                              ; Put 1st line center in.
   for k=1,3 do begin
redo:          vtmp = strtrim(string(4-k))          ; String of remaining #.
       print,' '
       print,'Use LEFT Mouse to find up to ',vtmp,' more line centers.'
       print,'Use MIDDLE Mouse if finished.'
       cursor,ix,iy                          ; Simple graphical input.
              if kdev eq 'xterm' then wait,1         ; X window?  Slow down.
       if !err eq 2 then goto,lcfin          ; Finished?  Get out.
       vtmp = where(exwa ge ix)              ; Get index of exwa cor-
       JE(k) = vtmp(0)                       ; responding to input.
              COMPARE,ix,RS,sdata,mp,mcntrl          ; Findout which LUT entry.
       if mp.cntrl eq 0 then goto, redo      ; If Not a good ID.
       xxx(0:1) = ix                         ; Good ID, get ready to
       oplot,xxx,yyy,linestyle=1             ;   plot it, dotted line.
       mdata(k) = sdata                      ; Update Multiple Meas.
       kk = kk + 1                           ; Increment counter.
           endfor
endif   ; ---------------------------------- ; END Redefine Line Cntrs.
lcfin:  if (kk gt 0) then JE = JE(0:kk)              ; How many line cntrs?
goto, START                                  ; Now go fit continuum.
     endif

     if iopt eq 4 then begin          ; Adjust # of points in the expanded plots?
for k=0,2 do print,' '
print,'MOVE CURSOR into the COMMAND WINDOW to input the number of points'
print,'in the Expanded Plots.  MSLAP starts with 150 points on either'
print,'side for 301 total.  NOTE: PROGRAM RETURNS TO CALLING ROUTINE'
nside = FIX(nside)
print,'Current setting is:',nside,' for a total of',2*nside+1,' points'
print,' '
read,'Enter the number of points on each side ',ntmp
if ntmp gt 0 then nside = ntmp
nside = FIX(nside)                           ; Make sure an integer.
goto, DONE
     endif
     if iopt eq 5 then goto,START                    ; Restart CONTIM.PRO.
     IF opt eq 9 THEN begin & STOP & goto, CHANGE & end ; Stop for kbd input.
     IF opt eq 6 THEN GOTO, DONE                     ; Get out of CONTIM.PRO.
```

```
    IF opt eq 3 THEN BEGIN                              ; Delete last .DTL measure.
dtl(mcntrl.I) = nulld
       PRINT,' Line ',mcntrl.I,'  has been DELETED! ',STRING(7B) ; Print notice
       mcntrl.I=mcntrl.I-1                               ; Set I to over write.
       IF mcntrl.I LT 0 THEN mcntrl.I=0                  ; Can't go negative.
    ENDIF                                               ;
    IF opt eq 4 then begin                              ; Comment on .DTL measure.?
  read,COMS
  sdata.com = byte(string(COMS,format='(a10)'))
    endif
    IF opt eq 2 THEN GOTO, DONE                         ; Return to Main Prog
    if opt le 4 then goto, CHANGE                       ; Rem.,Del.,Nothing
    if opt eq 7 then usrprog1,WA,SPECT,JJ,mp,up
    if opt eq 8 then usrprog2,WA,SPECT,JJ,mp,up
    if (opt eq 7) OR (opt eq 8) then goto, CHANGE       ; Usrprog called.
    if opt eq 5 then begin                              ; Hardcopy requested,
print,' ',string(7B)                          ; but is not allowed
print,'>>> HARD COPY is NOT available HERE <<<' ; Give Warning
print,'One can be made after each measurement'  ;
print,' '
    endif
    if opt eq 11 then goto,START                        ; New plot parameters.
endfor

;  --------  End Branching & Selecting Continuum Constraints   ----------------


calc: print,' '
      if imes ge 1 then XWRK(0) = cmes(0:imes-1,0)
      if imes ge 1 then YWRK(0) = cmes(0:imes-1,1)
      if (kget lt 2) AND (imes lt 2) then begin  ; >>> NOT ENOUGH END POINTS? <<<
         kchoice = wmenu(['Exit Continuum Fitting?','YES','NO'],title=0,init=1)
         if kchoice ne 1 then goto, CHANGE       ; Go get more option OR tell
 mp.cntrl = 0                              ;     calling routine ABORTED &
 goto, OUT                                 ;     get out.
      endif
      print,'  Calculating various polynomial fits and the statistics to perform'
      print,'  F TESTS for the validity of using higher order polynomials.'
      print,'                    -- Please Wait --'

;  ------ Strip out those portions that are featureless and put compactly  ---
;  ------ into vector XWRK.  Start at XWRK(jjj) each time through.  ----------

      k  = 0
      if imes gt 0 THEN jjj=imes-1 ELSE jjj=0     ; Start index after discrete pts
      for ii=0,kget/2-1 do begin                  ; Search for beginning and end-
  xtst = XLIMIT(2*ii)                       ; ing indices for featureless
         while EXWA(k) lt xtst do k=k+1         ; portions and stuff into XWRK.
  jj1 = k
  xtst = XLIMIT(2*ii+1)
         while EXWA(k) lt xtst do k=k+1
  jj2 = k
```

```
        XWRK(jjj) = EXWA(jj1:jj2)              ; Put into working array.
        YWRK(jjj) = EXSP(jj1:jj2)              ; Put into working array.
        jjj = jjj + jj2 - jj1                  ; # of elements in working array
      endfor

      if (imes lt 3) AND (kget eq 0) then begin  ; ---------- Straight line fit?
VSAV = where(EXWA ge cmes(0,0) AND EXWA le cmes(1,0))
        DYDX = (cmes(1,1)-cmes(0,1))/(cmes(1,0)-cmes(0,0))
        XWRK = EXWA(VSAV)
        YWRK = cmes(0,1) + DYDX*(XWRK-cmes(0,0)) ; Linear fit.
sz = size(XWRK)
jjj = sz(1) - 1
      endif

      xmx = max(XWRK(0:jjj),min=xmn)           ; Find range of abscissa.
      VSAV = where(EXWA ge xmn and EXWA le xmx)  ; VSAV is temporary array.
      J1 = VSAV(0)                             ; Determine starting and ending
      sz = size(VSAV)                          ; points for continuum vector
      J2 = VSAV(sz(1)-1)                       ; and store in J1 and J2.
      X0 = (xmx + xmn) / 2.0                   ; Adjust range to center on 0
      XWRK = XWRK(0:jjj) - X0                  ; Also adjust size of vectors
      YWRK = YWRK(0:jjj)                       ; to remove trailing zeros.
      VSAV = YWRK                              ; Make extra copy of YWRK
      jjj = jjj ;  - 1
      if (jjj lt 6) then begin                 ; Not enough points to fit?
 print,string(7B)
 print,'Warning: Poorly Defined Continuum'
 print,'Returning to Previous Level'
 return
      endif

;  ----  Find the best chi-squared fit  ------------------------------

      EE = dblarr(16)                          ; To hold residuals of var. fits
      mtot = mcntrl.mtot+2
      if mtot gt 9 then mtot = 9
      for m = 2,mtot+1 do begin                  ; m-1 order polynomials.
          MP1 = m + 1
          M2 = 2*m - 2
 BC(*) = 0.0
          CURFIT,XWRK,YWRK,AC,BC,MM,m,MP1,M2,1,jjj,2,0.0,0
 bcsav(m-1,*) = BC                         ; Save the fit parameters.
 EE(m-1) = total(YWRK(1:jjj-3)^2)          ; Sum of square of residuals.
          YWRK  = VSAV                           ; Replace destroyed spectra.
      endfor
      ENE = float(jjj-3)/COHFAC                  ; # of independent samples.
      EE = EE/COHFAC
      mcntrl.NNE = ENE                           ; Save for posterity.

      c_choice = string(bytarr(31,mcntrl.mtot+6))
      fdist = mcntrl.fdist
      m = 0
```

```
      mstp = 0
      f1w  = where(ene ge fdist(0,1:17),fcnt)
      if ene eq fdist(0,fcnt) then begin
f1n = fdist(1,fcnt)
f2n = fdist(2,fcnt)
      endif ELSE begin
f1n = (ene-fdist(0,fcnt))/(fdist(0,fcnt+1)-fdist(0,fcnt))
f2n = f1n*(fdist(2,fcnt+1)-fdist(2,fcnt))+fdist(2,fcnt)
f1n = f1n*(fdist(1,fcnt+1)-fdist(1,fcnt))+fdist(1,fcnt)
      endelse
      f1p   = string(format='(f6.2)',f1n)
      f2p   = string(format='(f6.2)',f2n)
      for k=1,mcntrl.mtot do begin
 fahd  = (ENE-k-3)*(EE(k)-EE(k+1))/EE(K+1)
 fahd2 = (ENE-k-4)*(EE(k)-EE(k+2))/(2.*EE(k+2))
 fdsav(0,k) = fahd
 fdsav(1,k) = fahd2
 if mstp eq 0 then m = k
 if (fahd le f1n) AND (fahd2 le f2n) then mstp = 1
 fahd  = string(format='(f6.2)',fahd)
 fahd2 = string(format='(f6.2)',fahd2)
 c_choice(k) = '  '+strtrim(string(k),2)+'   '+fahd+f1p+fahd2+f2p
      endfor
      mstp = string(format='(i2)',m)

final:BC = bcsav(m,0:15)                          ; Again with the best poly.
      MP1 = m + 1
      M2 = 2*m - 2
      XWRK = EXWA(J1:J2) - X0                     ; Take only valid part of
      YWRK = EXSP(J1:J2)                          ; wavelength and spectra.
      jjj = J2 - J1                               ; Total # of points in the fit.
      CURFIT,XWRK,YWRK,AC,BC,MM,m+1,MP1,M2,1,jjj,3,0.0,0  ; Fit & make continuum.
      CNT = float(YWRK(1:jjj-3))                  ; YWRK replaced with continuum.
      plot,EXWA,EXSP,/YNOZ                        ; Plot original spectrum.
      oplot,exwa,exsp,psym=8                      ; Overplot with large dots.
      sz = size(CNT)                              ; How many elements are there?
      xc = EXWA(J1:J1+sz(1))                      ; Size wavelength accordingly.
      oplot,xc,CNT                                ; Over plot fit continuum.
      if csav eq 1 then oplot,xc,cntsv,linestyle=2 ; Overplot prev. continuum.
      vtmp = where(XLIMIT gt 0,nxs)
      for k=1,nxs do begin                        ; Show range of continuum fit.
          ix = XLIMIT(k-1)
          xyouts,ix,yout,':'+strtrim(k,2)
      endfor

;  --- Get the choice of Polynomical and Type of Integration ---------------

getch: print,' ' & print,' '
       mstr = string(format='(i2)',m)
if mstr eq mstp then begin
   print,'The recommended Order is',mstp,' (highlighted), but you may select another.'
endif ELSE begin
```

```
          oplot,xxx(k,0:1),yyy,linestyle=1    ; Flag the plot too.
    TVCRS,xxx(k,0),yhalf,/DATA          ; Repeat Cursor command, insure.
    print,' '
          print,'Cross-Hairs INPUT the left edge of the integration range.'
    print,'                - Only horizonatal position will be used.'
          CURSOR,IX,IY                          ; Read left (beginning) point.
          if kdev eq 'xterm' then wait,1        ; X windows too fast, slow it.
          PRINT,STRING(7B)                      ; Ring the bell.
          if lcs gt 1 then XI(k)=IX  else  XI=IX  ; Store start pt as array?
    print,' '
          print,'Cross-Hairs INPUT the right edge of the integration range.'
    print,'                - Only horizonatal position will be used.'
          CURSOR,JX,JY                          ; Read right (final) point.
          if kdev eq 'xterm' then wait,1        ; X windows too fast, slow it.
          PRINT,STRING(7B)                      ; Ring the bell.
          if lcs gt 1 then XF(k)=JX  else  XF=JX  ; Store stop pt as array?

    if (xxx(k,0) lt IX) OR (xxx(k,0) gt JX) then begin
       print,string(7B)
       print,'Warning: Integration Window does not contain'
       print,'         Center Wavelength defined before.'
       print,' '
       goto, setrng
            endif
        endfor
     endif                                      ; End kchoice < 6.

     if kchoice eq 6 then begin                 ; kchoice=> Use Fixed Window
if mp.window eq 0 then begin            ; Has one already been selected?
   vtmp = 0.0                           ; If not, read window & store.
   read,'Enter Full Width of window in km/s ',vtmp
   mp.window = vtmp
        endif
print,'Will use standard window of ',mp.window
vtmp = mp.window/2.9979e5               ; Convert to unitless value.
        XF=EXWA(JE)+EXWA(JE)*vtmp/2.            ; Wavelength integration
        XI=EXWA(JE)-EXWA(JE)*vtmp/2.            ; window around line center.
     endif

     if kchoice eq 7 then mcntrl.intopt=0 else mcntrl.intopt=1  ; Use ALT_INT.

     JE = JE - J1                               ; Adjust line center index.
     sz = size(CNT)
     EXWA = EXWA(J1:J1+sz(1))                   ; Stip out only necessary parts.
     EXSP = EXSP(J1:J1+sz(1))                   ; Stip out only necessary parts.
     mcntrl.ESAV = sqrt(EE(m)/(ENE - float(m))) ; Save error of the fit.
;
;                                               ;
DONE:  PRINT,''                                 ; Let's get out of here.
   mp.cntrl = 1                                 ; Set flag to OK
   IF (opt eq 2) THEN mp.cntrl = 0              ; or EXIT, No Measurement
   IF (iopt eq 4) THEN mp.cntrl = 0             ; or EXIT, No Measurement
```

```
   print,'REMINDER: the recommended Order is',mstp
endelse
print,'To assist in other choices: X is the observational difference in the'
print,'reduced chi squares divided by the reduced chi square, which if larger'
print,'than the theoretical F(1,n) indicates that going to the next higher order'
print,'polynomial is justified statistically.  Y is similar to X except it is'
print,'for comparison to F(2,n), an order that is 2 higher.  The F Distributions'
print,'are at the 5% confidence level for:',fix(ene),' points.'

      print,' '
      print,'Select the Order of the Polynomial'
      print,'       - Other Polynomials may be examined before deciding.'
      print,'       - Selecting order',mstr,' implies use that polynomial.'
      c_choice(0) = 'Order    X   F(1,n)  Y    F(2,n)'
      c_choice(6) = 'Order: '+mstr+', Predetermined window'
      c_choice(7) = 'Order: '+mstr+', Use ALT_INT Routine'
      if csav eq 0 then c_choice(8) = 'Toggle ON Overplot Last Cont.'
      if csav eq 1 then c_choice(8) = 'Toggle OFF Overplot Last Cont.'
      c_choice(9) = 'Restart Fitting'
      c_choice(10)= 'Abort - RETURN to Prev. Level'
      kchoice = wmenu(c_choice,title=0, init=m)
      if kchoice lt 1 then goto, getch          ; Not valid - do it again.

;  --- Implement the choice ---------------------------------------------

      if kchoice eq 10 then opt = 2             ; Abort - pretend set by USRMENU
      if kchoice eq 10 then goto, DONE          ; then go to the bottom.
      if csav eq 1 then cntsv = CNT
      if kchoice eq 8 then begin                ; Toggle Overplot last continuum
 vtmp = csav
 if vtmp eq 1 then csav = 0
 if vtmp eq 0 then csav = 1
        if csav eq 1 then cntsv = CNT
 goto, getch
      endif
      TVCRS,0.5,0.5,/NORMAL                     ; Put Cross-hairs on screen.
      XI = min(XLIMIT)                          ; Set integration range to the
      XF = max(XLIMIT)                          ; maximum allowed by spectrum.
      if kchoice eq 9 then goto, START          ; kchoice => restart
      if (kchoice ne m) and (kchoice lt 6) then begin   ; Different order?
 m = kchoice                                ; Set order to user choice.
 goto, final                                ; Go display different order.
      endif
      if kchoice lt 6 then begin                ; kchoice => Settled on order #.
         TVCRS,0.5,0.5,/NORMAL                  ; Put Cross hairs on screen.
         if lcs gt 1 then XI=fltarr(lcs)  else  XI=0.  ; Multiple features?  If
         if lcs gt 1 then XF=fltarr(lcs)  else  XF=0.  ; so, get ready.
         for k=0,lcs-1 do begin
setrng:     if lcs eq 1 then xxx(k,0:1) = EXWA(JE)    ; Get feature center.
            if lcs gt 1 then xxx(k,0:1) = EXWA(JE(k)) ; Do same if multiple ones
     TVCRS,0.5,0.5,/NORMAL                  ; Put Cursors on the graph.
     TVCRS,xxx(k,0),yhalf,/DATA             ; Put Cursors on the feature.
```

```
    IF opt eq 6  THEN mp.cntrl = 2              ; or EXIT to NEXT spect.

OUT:  print,' '
      mp.poly = m                               ; Store in MSLAP structure.
      mcntrl.f1n = fdsav(0,m)
      mcntrl.f2n = fdsav(1,m)

RETURN                                          ; go back to DETAILS
END ; CONTIM                                    ;
;
;
PRO STORE,WW,ML,dtl,mdata,mp,mcntrl,up
;********************************  STORE.PRO  *********************************
;
;       TO WRITE OUT THE FILES FOR DETAILS
;       by Charles L. Joseph                    June 1982    May 1990
;
;           ML          maximum number of measurements that can be made.
;
;*******************************************************************************

    iafs = mdata.iaf                                    ; Get the Ion Codes.
    iafs = where(iafs ne 0,sz)                          ; How much incoming data?
    if sz eq 0 then goto, RET
    IF (mcntrl.I+SZ) GE ML THEN BEGIN                   ; forced exit if too
        ERROR = 66                                      ; many lines. set flag
        PRINT,'Too many lines measured!',STRING(7B)     ; tell them
        YN=''
        READ,'use <RETURN> to exit',YN
        GOTO,RET                                        ; exit
    END                                                 ; go back to DETAILS
    IF mcntrl.I+10 GE ML THEN BEGIN
        PRINT,STRING(7B)
        PRINT,'Within 10 measurements of the maximum allowed'
        WAIT,4
    END
    IF mcntrl.I LT 0 THEN mcntrl.I = 0                  ; can't have I < 0
    openu,1,mp.STAR+'.DTL'
    readu,1,dtl
    close,1
    for k=0,sz-1 do begin                               ; Add all new data to old
        sdata = mdata(k)
        dtl(mcntrl.I) = sdata
        print,FORMAT='("Storing measurement:",i3,3x,a10)', $
      mcntrl.I,string(sdata.el)
        mcntrl.I=mcntrl.I+1                             ;increment masterindex
        IF mcntrl.I GE ML THEN mcntrl.I=ML-1            ; catch over run
    endfor                                              ;
;                                                       ;or write file & exit
;                                                       ; store data on disk
    openu,1,mp.STAR+'.DTL'
    writeu,1,dtl
```

```
    CLOSE,1                                                    ; close file
;                                                              ;or write file & exit
RET:                                                           ;
RETURN                                                         ; go back to DETAILS
END                                                            ; to exit normally
;
;
;
pro fstore,tau,sdata,mp,mcntrl,up
;******************************  FSTORE.PRO  *********************************
;
;  To store the flux, wavelength, continuum, and optical-depth vectors.
;  by Charles L. Joseph                                  May 1990
;
;
;*****************************************************************************

;  -------------- Plot Optical Depths before storing them -----------------

aax = fltarr(5)                                                ; Make usersymbol of an
aay = aax                                                      ;   arrow for L.L.
aax = [0.,0.,-0.25,0.,0.25]                                    ; Values for an arrow
aay = [0.,3.0,2.6,3.0,2.6]                                     ;   (Lower Limit).

!y.margin(0) = 4.
v = 2.9979e5*(tau(0,*)- sdata.wl)/sdata.wl
asy = findgen(16)*(!PI*2/16.)
usersym,0.5*cos(asy),0.5*sin(asy),/FILL
plot,v,tau(2,*),xtitle='velocity',ytitle='log tau',psym=8, $
     yrange=[-2.5,1.5],ystyle=1
usersym,0.5*cos(asy),0.5*sin(asy)
oplot,v,tau(1,*),psym=8
oplot,v,tau(3,*),psym=8
usersym,aax,aay
ttmp = where(tau(2,*) gt 1.0,tcnt)                             ; Which are limits?
if tcnt gt 1 then oplot,v(ttmp),tau(2,ttmp),psym=8             ; Over plot lower limits
if tcnt eq 1 then oplot,[v(ttmp),v(ttmp)],[tau(2,ttmp),tau(2,ttmp)],psym=8
ttmp = where(tau(3,*) gt 1.0,tcnt)                             ; Which are limits?
if tcnt gt 1 then oplot,v(ttmp),tau(3,ttmp),psym=8             ; Error's Lower Limits.
if tcnt eq 1 then oplot,[v(ttmp),v(ttmp)],[tau(3,ttmp),tau(3,ttmp)],psym=8
fval = string(format='(f6.4)',sdata.f)
fval = '     f = '+fval
print,' '
print,'Log Tau Plot    Rest Wavelength:',sdata.wl,'     ',fval

kwtd = wmenu(['Copy?','Yes','No'],title=0, init=2)
if kwtd then begin
   plotconfig,1,' ',' ',-1,kdev,''                             ; Config. for Hardcopy.
   asy = findgen(16)*(!PI*2/16.)
   usersym,0.8*cos(asy),0.8*sin(asy),/FILL
   plot,v,tau(2,*), xtitle='velocity',ytitle='log tau',psym=8, $
yrange=[-2.5,1.5],ystyle=1
```

```
   usersym,0.5*cos(asy),0.5*sin(asy)
   oplot,v,tau(1,*),psym=8
   oplot,v,tau(3,*),psym=8
   usersym,aax,aay
   ttmp = where(tau(2,*) gt 1.0,tcnt)                    ; Which are limits?
   if tcnt gt 1 then oplot,v(ttmp),tau(2,ttmp),psym=8    ; Over plot lower limits
   if tcnt eq 1 then oplot,[v(ttmp),v(ttmp)],[tau(2,ttmp),tau(2,ttmp)],psym=8
   ttmp = where(tau(3,*) gt 1.0,tcnt)                    ; Which are limits?
   if tcnt gt 1 then oplot,v(ttmp),tau(3,ttmp),psym=8    ; Error's Lower Limits.
   if tcnt eq 1 then oplot,[v(ttmp),v(ttmp)],[tau(3,ttmp),tau(3,ttmp)],psym=8
   xxo=0.0*(!x.crange(1)-!x.crange(0)) + !x.crange(0)
   yyo=1.06*(!y.crange(1)-!y.crange(0)) + !y.crange(0)
   xyouts,xxo,yyo,mp.FNAM
   xxo=0.4*(!x.crange(1)-!x.crange(0)) + !x.crange(0)
   xyouts,xxo,yyo,string(sdata.el)+strtrim(string(sdata.wl),2)
   xxo=0.7*(!x.crange(1)-!x.crange(0)) + !x.crange(0)
   xyouts,xxo,yyo,mcntrl.date
   plotconfig,-1,' ',' ',-1,kdev,''                      ; Send plot & -> term.
endif

;  ------------ First Retrieve & Update Header Information --------------------

   as  = assoc(5,fltarr(200))                          ; Association variables for
   tas = assoc(5,fltarr(2,600))                        ;      random disk access.
   close,5
   openr,5,mp.STAR+'.TAU', ERROR = errtst              ; Test if file exists.
   close,5
   if errtst ne 0 then begin                           ; No file so create one.
      openw,5,mp.STAR+'.TAU'                           ; Open a new file.
      for k=0,5 do as(k) = fltarr(200)                 ; Make 6 dummy records.
      close,5                                          ; Now close it.
   endif
   openu,5,mp.STAR+'.TAU'                              ; Open file for Update & get
   iafs  = as(0)                                       ; 1st record - species codes
   rwav  = as(1)                                       ; Get prev. rest wavelengths
   bgs   = as(2)                                       ; Get previous BG levels.
   bgers = as(3)                                       ; Get previous BG errors.
   dates = as(4)                                       ; Get previous date codes.
   lwfs  = as(5)                                       ; Get prev. log f-lambdas.

   itau = TOTAL(iafs ne 0)                             ; Total number before?

   iafs(itau)  = long(sdata.iaf)                       ; Add new species code.
   print,iafs(itau)
   if iafs(itau) lt 0 then stop
   rwav(itau)  = sdata.wl                              ; Add current lab wavelength
   bgs(itau)   = mp.bg                                 ; Add current BG level.
   bgers(itau) = mp.bgerr                              ; Add current BG error.
   dates(itau) = 910112                                ; Add current date.
   lwfs(itau)  = alog10(sdata.wl*sdata.f)              ; Add new log f-lambda.

;  ----------- Next Store, Header, Optical Depths + Spectra -----------------
```

```
   tautmp = fltarr(2,600)                          ; Make temporary array.
   sz = size(tau)                                  ; Find size of incoming data
   if sz(0) le 0 then begin                        ; If no incoming, get out.
      print,string(7B),''                          ; Ring the alarm BELL.
      print,'WARNING: No Optical Depth Data"
      wait,2                                       ; 2 seconds to see it.
      close,5                                      ; Close the file.
      return                                       ; No saving it, return.
   endif
   sz = sz(2)                                      ; Change info. to a scalar.

   as(0) = iafs                                    ; Store updates of record-
   as(1) = rwav                                    ;   keeping and header info.
   as(2) = bgs                                     ;   back to the disk file.
   as(3) = bgers
   as(4) = dates
   as(5) = lwfs

   tautmp(0:1,0:sz-1) = tau(0:1,*)                 ; Stuff Wavelength & TAUs(-)
   tas(3*itau+1)      = tautmp                     ;       and write to disk.
   tautmp(0:1,0:sz-1) = tau(2:3,*)                 ; Stuff TAU's and TAUs(+)
   tas(3*itau+2)      = tautmp                     ;       and write to disk.
   tautmp(0:1,0:sz-1) = tau(4:5,*)                 ; Stuff Spectrum & Continuum
   tas(3*itau+3)      = tautmp                     ;       and write to disk.

close,5                                            ; Close file and return.
return
end
;
;
;
PRO EXPAND,JO,JS,WA,WS,JT,JE,J,nside
;************************** EXPAND.PRO ***********************************
;
;      TO EXPAND THE FLUX AND WAVELENGTH VECTORS.
;      by Charles L. Joseph                              Sept 1980.
;
;        JO       flux vector
;        JS       expanded flux vector
;        WA       wavelength vector
;        WS       expanded wavelength vector
;        JT       number of points in expanded vectors
;        JE       central index of vectors ( expanded )
;        J        index of cursor position
;
;
;*****************************************************************************
;
    nsave = nside                                  ; Save the request.
    NPTS=TOTAL(WA GT WA(0))                        ; # of points in vector
    JT = 2*nside + 1                               ; # of expansion points
```

```
    if (NPTS lt JT) then nside = FIX(NPTS/2) - 1        ; Adequate # of points?
    if J lt nside then jfact = nside - J else jfact = 0 ; Too close to lft edge?
    if (NPTS-J) lt nside then jfact = NPTS - J - nside  ; Too close to rt edge?
    JS = JO(J+jfact-nside:J+jfact+nside)
    WS = WA(J+jfact-nside:J+jfact+nside)
    JE = nside + 1 - jfact                              ; Index of line center.
    nside = nsave                                       ; Restore the request.
RETURN
END                                                     ;
;
;
;
; ######################################################################
;
;                           MAIN PROGRAM
;
;                    by Charles L. Joseph    May 12, 1990
;
; ######################################################################
;
     date='Fri Apr 13 00:00:01 1990'                    ;
     date = systime(0)                                  ; Get time and date
     date = strmid(date,4,7)+strmid(date,20,4)          ; Strip out date
     up = fltarr(30)
ST:  for k=1,13 do print,' '
     print,date                                         ;
     NUM = 0                                            ; reset NUM
     libr = '/u/clj/mslapdir'                           ; Defines the MSLAP lib.
     spawn,'head -26 '+libr+'/main.mslap'               ; print 1st 31 lines.
     for k=1,3 do print,' '
     READ,'Which option would you like ? ',NUM          ; what to do
     IF NUM EQ 10 THEN GOTO,OUT                         ; to get out
;                                                       ;
;                                                       ;
;    DETAILS OR POSTO
;                                                       ;
;                                                       ;
     IF NUM EQ 1 THEN DETAILS,0,date,libr,up            ; run DETAILS no tau's
     IF NUM EQ 2 THEN DETAILS,1,date,libr,up            ; run DETAILS with tau's
     IF (NUM ge 3) AND (NUM le 6) THEN BEGIN            ; POSTO, EDATDTL, COGS
;
GSTAR:  STAR=' '                                        ;   set up loop
READ,'What is the file name, created in Option #1 or #2 ?',STAR
        IF STAR EQ 'H' THEN BEGIN                       ; Want help?
           SPAWN,'ls *.DTL'                             ; Give a listing and
           GOTO,GSTAR                                   ; go back try again.
        END                                             ;
        if NUM ne 5 then openr,1,STAR+'.DTL', ERROR = errtst ; See if file exist.
        if NUM eq 5 then openr,1,STAR+'.TAU', ERROR = errtst ; See if file exist.
        close,1                                         ; Close again.
        if errtst ne 0 then begin                       ; Oops no file
           YNO=''                                       ;
```

```
   if NUM eq 4 then read,'Create Dummy File?',YNO  ; EDATDTL? Use dummy?
          if (YNO eq 'Y') OR (YNO eq 'y') then goto,CHOICES
          YNO=''                                   ; Try another file?
          READ,'Would you like to try another FILE ?',YNO
          if (YNO eq 'Y') OR (YNO eq 'y') then goto,GSTAR
          GOTO,ST                                  ; else goto start
       END                                         ;
    END                                            ;
CHOICES:                                           ;
    IF NUM EQ 3 THEN POSTO,STAR                    ; run POSTO
    IF NUM EQ 4 THEN edatdtl,STAR                  ; run EDATDTL
;                                                  ;
    IF NUM EQ 5 THEN mantau,STAR,date
;                                                  ;
    IF NUM EQ 6 THEN cog,STAR,date,libr

       GOTO,ST                                     ;  go back to start
OUT:  ;                                              ; tty mode
END                                                ;


;  ***************************************************************************
;   This file contains many procedures or indirect calls to compile procedures
;   used by M.S.L.A.P.  These contain some of the standard as well as the
;   dummy routines that may be over layed by editing the mslap.pro routine
;   in the user's local directory.
;
;              Charles L. Joseph     December 24, 1990
;
;  ***************************************************************************
;
@/u/clj/mslapdir/mantau
@/u/clj/mslapdir/intgrt.pro
@/u/clj/mslapdir/edatdtl
@/u/clj/mslapdir/posto
@/u/clj/mslapdir/cog
@/u/clj/mslapdir/plotconfig
@/u/clj/mslapdir/compare.pro
pro dget1,FNAME,w,spect,q,ihdr,ID,mp,up
    mp.dget  = 0                                   ; These are dummy routines
    ID = 'NOT Being Used'                          ; which reserve slots for
return                                             ; real ones that will be
end                                                ; plugged in.
pro dget2,FNAME,w,spect,q,ihdr,ID,mp,up
    mp.dget = 0
    ID = 'NOT Being Used'
return
end
pro dget3,FNAME,w,spect,q,ihdr,ID,mp,up
    mp.dget = 0
    ID = 'NOT Being Used'
return
```

```
end
pro dget4,FNAME,w,spect,q,ihdr,ID,mp,up
    mp.dget = 0
    ID = 'NOT Being Used'
return
end
pro dget5,FNAME,w,spect,q,ihdr,ID,mp,up
    mp.dget  = 0
    ID = 'NOT Being Used'
return
end

;
;
; ****************************************************************************
;   PROGRAM CURFIT  -calculates ploynomial fits for CONTIM.
;   By Edward B. Jenkins
;   Translated to IDL and Edited by Charles L. Joseph  May 1990
;
; ORDER OF POLYNOM.  = M ;  MP1 = M + 1 AND M2 = 2*M - 2
; ARRAY WILL BE PROCESSED FROM INDEX "NS" TO INDEX "N"
; IF SOME POSITIONS IN THE ARRAY BETWEEN INDICES NS AND N ARE TO BE IGNORED,
; JUST SET THE APPROPRIATE Y VALUES GREATER THAN 1.D30
; MODE = 0 JUST EVALUATES ANSWER VECTOR B
; MODE = 1 EVALUATES B AND REPLACES Y BY BEST FIT CURVE
; MODE = 2 EVALUATES B AND REPLACES Y BY RESIDUALS
; MODE = 3 COMPUTES BEST FIT CURVE FROM EXISTING X AND B ARRAYS
; XMUL = 0.DO TELLS SUBROUTINE TO REFERENCE X ARRAY; OTHERWISE X IS IGNORED
; LOGIND = 0 DOES ORDINARY FIT; IF LOGIND .GT. 0, COEFF'S ARE IN TERMS OF LOG Y
;  IMPLICIT REAL*8(A-H,O-Z)
;  DIMENSION Y(N),A(M,MP1),B(M2),MM(M),X(N)
; ****************************************************************************

PRO CURFIT,X,Y,A,B,MM,M,MP1,M2,NS,N,MODE,XMUL,LOGIND
   IF MODE EQ 3 then GOTO,COMP                              ; Go compute polynom.
   A = 0.0*A                                                ; Zero A and B arrays
   B = 0.0*B
   A(0,0) = N - NS + 1                                      ; A(0,0)= # of points
   FOR I = NS,N DO BEGIN
      IF Y(I-1) GE 1.e70 THEN A(0,0) = A(0,0) - 1.  ELSE  BEGIN
         IF XMUL EQ 0 THEN XP = X(I-1) ELSE XP = double(I)*XMUL
         XX = XP
         B(0) = B(0) + XP
         IF LOGIND GT 0 THEN Y(I-1) = double(alog(Y(I-1)))
         A(0,MP1-1) = A(0,MP1-1) + Y(I-1)
         FOR J = 2,M DO BEGIN
            A(J-1,MP1-1) = A(J-1,MP1-1) + Y(I-1)*XP
            XP = XP*XX
            B(J-1) = B(J-1) + XP
         ENDFOR
         IF LOGIND GT 0 THEN Y(I-1) = double(EXP(Y(I-1)))
         FOR J= MP1,M2 DO BEGIN
```

```
            XP = XP*XX
            B(J-1) = B(J-1) + XP
         ENDFOR
      ENDELSE
   ENDFOR                                                    ;    6 CONTINUE
   MS = 2
   FOR I=1,M DO BEGIN
      FOR J = MS,M DO BEGIN
      IPJ = I + J - 2
      A(I-1,J-1) = B(IPJ-1)
      ENDFOR
   MS = 1
   ENDFOR
   EQSOL,A,M,MP1,B,MM                                        ;  CALL EQSOL
   IF MODE EQ 0 THEN RETURN
COMP: FOR I = MS,N-1 DO BEGIN
      IF XMUL EQ 0 THEN XP = X(I-1) ELSE XP = double(I-1)*XMUL
      XX = XP
      YCOMP = B(0)
      FOR J = 2,M DO BEGIN
         YCOMP = YCOMP + B(J-1)*XP
         XP = XP*XX
         ENDFOR
      IF LOGIND GT 0 THEN YCOMP = double(EXP(YCOMP))
      IF (MODE EQ 2) AND (Y(I-1) LT 1.D70) then Y(I-1) = Y(I-1) - YCOMP
      IF MODE NE 2 THEN Y(I-1) = YCOMP
   ENDFOR
RETURN
END

; ***************************************************************************
;
;  PROGRAM EQSOL - To solve Differential Equation for CURFIT.
;   By Edward B. Jenkins
;   Translated to IDL and Edited by Charles L. Joseph  May 1990
;
; ***************************************************************************

pro eqsol,a,n,nn,x,m
; a = fltarr(n,nn)
; x = fltarr(n)
; m = intarr(n)
for i = 1,n do begin
    m(i-1) = 1
    amax = a(i-1,0)
    for j = 2,n do begin
if ((abs(a(i-1,j-1))-abs(amax)) gt 0) then begin
   amax = a(i-1,j-1)
   m(i-1) = j
        endif
    endfor
    for j = 1,nn do begin
```

```
        if(amax eq 0) then print,'about to divide by amax=0 in EQSOL'
        a(i-1,j-1) = a(i-1,j-1)/amax
     endfor
     for ip = 1,n do begin
if (ip - i) ne 0 then begin
   mmm = m(i-1)
   zmult = a(ip-1,mmm-1)
   for j=1,nn do if (j-mmm) eq 0  then  a(ip-1,j-1) = 0  $
       else  a(ip-1,j-1) = a(ip-1,j-1)-zmult*a(i-1,j-1)
        endif
     endfor
endfor
for i = 1,n do begin
     mmm = m(i-1)
     x(mmm-1) = a(i-1,nn-1)
endfor

return
end
; ---------------------------------------------------------------------
;  PROGRAM UCURSOR  to provide continuous readout of cursor position unitl
;  the mouse is clicked.  The left and middle mouse buttons return to calling
;  routine, while the right button brings up a menu of options.  If the
;  graphics device is not a SUN, control information is can be passed by the
;  key used to input the cursor location.
;
;  cflg = 0  use Main UserMENU.          Selection is returned in opt parameter.
;  cflg = 1  use Continuum MENU first.  Selection is returned in iopt param.
;  cflg < 0  NO Menu, reserve right mouse button for other purposes.
;  Coordinates are returned in IX and IY.
;  See main.mslap for definitions of the mp structure.
;
;  By Charles L. Joseph          6/4/90          Latest Revision: 1/7/91
;  ---------------------------------------------------------------------

pro ucursor,IX,IY,opt,iopt,cflg,mp

  vflg = 0

START: ;

  opt  = 9999
  iopt = 9999
  kdev = getenv('TERM')
  if kdev eq 'vt300' then kdev = 'xterm'
  if (kdev eq 'xterm') OR (kdev eq 'sun') then begin
     xout1 = 0.0*(!x.crange(1)-!x.crange(0)) + !x.crange(0)
     xout2 = 0.5*(!x.crange(1)-!x.crange(0)) + !x.crange(0)
     youta = 0.5*(!y.crange(1)-!y.crange(0)) + !y.crange(0)
     tst = 0
     while (tst ne 1) do begin                    ; Continuous readout of cursor
           cursor,IX,IY,/CHANGE                   ; coordintes.
```

```
            if !ERR eq 1 then tst = 1              ; if true - left mouse
            if !ERR eq 2 then tst = 1              ; if true - middle mouse
            if !ERR eq 4 then tst = 1              ; if true - right mouse
            wset,1                                 ; Set to cursor printing window
            erase                                  ; Clear and print new coords.
   if vflg then xcrd=2.9979e5*(IX-wavrest)/wavrest ELSE xcrd = IX
            xyouts,xout1,youta,string(format='(f9.3)',xcrd)
            if (youta lt 600) then xyouts,xout2,youta,string(format='(f9.3)',IY)
            if (youta ge 600) then xyouts,xout2,youta,string(format='(f9.0)',IY)
            wset,0                                 ; Return to plotting window.
      endwhile
      if kdev eq 'xterm' then wait,1
      if !ERR eq 2 then return                     ; Exit this routine if middle
      if !ERR eq 1 then return                     ; or left mouse used, otherwise
; a MENU is wanted.

;  ----------------- OLD Tektronics type Cursors -----------------------

  endif  else begin
     CURSOR,IX,IY                                  ;  what to do?
     PRINT,STRING(7B)                              ;    4025
  endelse

;  --------------  Get Various UserMenu Options   ---------------------

  if cflg lt 0 then return                         ; No Menu Options Wanted
     ; under any circumstances.

;  If cursor reading is out side of plot area, or the right mouse button used,
;  then set menuflg=1 to get a menu.  If calling routine is the Continuum
;  fitting routine (cflg=1), then call special menu defined below.  Otherwise
;  (cflg=0), call Main UserMenu.

  menuflg = 0
  if((IX lt !x.crange(0)) or (IX gt !x.crange(1))) then menuflg = 1
  if((IY lt !y.crange(0)) or (IY gt !y.crange(1))) then menuflg = 1
  if (!ERR eq 4) and (cflg eq 0) then usrmenu,opt    ; Not in Continuum Routine.
  if (!ERR eq 4) and (cflg eq 1) then menuflg = 1    ; In Continuum Routine.

  if menuflg then begin                            ; First MENU for Continuum
     c_opts = string(bytarr(22,7))                 ; routine.  Option 4 calls
     c_opts(0) = 'Continuum Options'               ; Main UserMenu.
     c_opts(1) = 'Take No Action'
     c_opts(2) = 'Descrete Cont. Points'
     c_opts(3) = 'Define Profile Cntr(s)'
     c_opts(4) = 'Change EXPANSION size'
     c_opts(5) = 'Restart Continuum Fit'
     c_opts(6) = 'Call MAIN userMENU'
     iopt = wmenu(c_opts, title=0, init=1)         ; Get iopt option.
     if iopt eq 6 then usrmenu,opt
   endif
```

```
  if (opt eq 10) OR (opt eq 12) then begin          ; Set up to display velocity
     print,string(7B),' '
     if opt eq 10 then begin
        print,'Find Wavelength of Interest and Click any Mouse'
        print,'X-Coordinte will then read in velocity'
     endif
     if opt eq 12 then begin
print,'Locate Backround Level and Click LEFT Mouse -- then'
print,'offset vertically by 1 standard deviation and Click again.'
print,'If you wish to enter the numbers manually, Click RIGHT Mouse.'
     endif
     tst = 0
     while (tst ne 1) do begin                      ; Continuously read wave-
           cursor,IX,IY,/CHANGE                     ; length position of cursor.
           if !ERR eq 1 then tst = 1
           if !ERR eq 2 then tst = 1                ; Cursor reading provides
           if !ERR eq 4 then tst = 1                ; reference wavelength.
           wset,1
           erase
           xyouts,xout1,youta,string(format='(f9.3)',IX)
           xyouts,xout2,youta,string(format='(f9.3)',IY)
           wset,0
     endwhile
     wavrest = IX                                   ; Start this routine over,
     vflg = 1                                       ; using velocity instead of
     if opt eq 10 then goto, START                  ; wavelength.
     if opt eq 12 then begin
if !ERR eq 4 then begin
           print,' ',string(7B)
           Print,'Move cursor into COMMAND window for input.'
           Read,'Enter background: ',bg
           mp.bg = bg
           read,'Enter uncertainty: ',bg
           mp.bgerr = bg
        endif ELSE begin
   print,''
   print,'Now locate a 1 sigma deviation.'
   mp.bg = IY
   cursor,IX,IY
   if IY gt mp.bg THEN mp.bgerr=IY-mp.bg ELSE mp.bgerr=mp.bg-IY
endelse
     endif
  endif
  if opt eq 11 then begin
     print,' ',string(7B)
     Print,'Move cursor into COMMAND window for input of New Plot Parameters.'
     print,' '
     read,'Enter min and max values for the X axis: ',x1,x2
     read,'Enter min and max values for the Y axis: ',y1,y2
     !x.range = [ x1, x2 ]
     !y.range = [ y1, y2 ]
  endif
```

```
RETURN
END ; UCURSOR
;
;
;
PRO dataget,WA,SPECT,JJ,IHDR,FF,mp,mcntrl,up
;
;****************************** dataget.pro ********************************
;
;       To get the Spectrum Data.   -- formerly inside GRAPHS.PRO
;       This routine interfaces the data-getting routines of DGETS to DETAILS.
;       By Charles L. Joseph                    May 1990
;
;       SPECT     flux vector
;       WA        wavelength vector
;       IHDER     header vector
;       FF        data type flag
;       JJ        data quality vector
;
;*****************************************************************************
     COMMON BLOCK1,DTY,SMO                                  ; get common

  FNAME = mp.FNAM
  IF mp.cntrl EQ -1 THEN begin                      ; 1st time through
START: FNAME = ' '                                    ; create blank name
       for k=0,1 do print,' '
       print,'Enter complete INPUT Data Filename'  ;
       read,'Including the path if necessary ',FNAME; read file name
       if (FNAME eq 'end') OR (FNAME eq 'END') then begin
          mp.cntrl = -99
          return
       endif
       if FNAME eq 'H' then begin
          for k=0,2 do print,' '
          spawn,'ls'
          for k=0,2 do print,' '
          print,'>>>>> Note: entering the word "end" exits <<<<'
          goto,START
       endif
       close,1                                          ; close logical unit
       openr,1,FNAME, ERROR = errtst                    ; check that it exists
       close,1
       if errtst ne 0 then begin                        ; a problem if nonzero
  print,' ',string(7B)                          ; send beep
  print,'Warning:  Unable to read file'     ; print warning
  yno = ' '
  read,'Try to input again? ',yno
  if (yno eq '1') OR (yno eq 'y') then goto,START
  mp.cntrl = -99
  return                                        ; return to MSLAP
       endif
```

```
COHFIND: cohfac = 0
   print,string(7B),' '
   print,' '
   print,'IMPORTANT: The coherence length is used to calculate ALL uncertainties.'
   print,'It is the number of pixels influencing the value in a given pixel.'
   print,'Thus, the coherence length must be 1 or greater.  For example, data
   print,'smoothed by a 3-point Running Box Car has a coherence length of 3.'
   print,string(7B),' '
   read,'What is the coherence length of the present data?',cohfac
   mp.cohfac = cohfac
   if mp.cohfac lt 1 then goto, COHFIND
   mp.bg = 0.0                                    ; Assume background &
   mp.bgerr = 0.0                                 ; error initially.
  endif
;
 mp.FNAM = FNAME
 IF FF EQ 1 THEN dget1,FNAME,WA,SPECT,JJ,IHDR,ID,mp,up
 IF FF EQ 2 THEN dget2,FNAME,WA,SPECT,JJ,IHDR,ID,mp,up
 IF FF EQ 3 THEN dget3,FNAME,WA,SPECT,JJ,IHDR,ID,mp,up
 IF FF EQ 4 THEN dget4,FNAME,WA,SPECT,JJ,IHDR,ID,mp,up
 IF FF EQ 5 THEN dget5,FNAME,WA,SPECT,JJ,IHDR,ID,mp,up
 if (FF lt 1) OR (FF gt 5) then print,'Invalid File Option'
 print,' '
 print,'New Data Have Been Read     --   Data Getting Option:',fix(FF)

 if mp.cntrl eq -1 then begin                   ; Determine tollerance for
    sz = size(WA)                               ;   finding entry in ULUT.
    if sz(0) eq 0 then mp.cntrl = -99           ; Just in case problem with DGET,
    if mp.cntrl eq -99 then begin
       print,string(7B),'WARNING: Data-Getting Routine returned a vector'
       print,'         that has ZERO elements!  -- Returning to MENU'
       wait,3
    endif
    if sz(0) eq 0 then return                   ;   indicate an abort & exit.
    wavetol = 10*(WA(sz(1)-1)-WA(0))/sz(1)      ; Tollerance = +/- 10 pixels, but
    if wavetol lt 0.5 then wavetol = 0.5        ;   never less than 0.5 Angstrom.
    mcntrl.wtol = wavetol                       ; Save for COMPARE.
 endif

 print,' ',string(7B)
 print,' ------------------------------------------------------------------'
 print,' | The background uncertainty frequently has a major impact on the  |'
 print,' | uncertainty of the various measurements.                         |'
 print,' | Current background is:',mp.bg,' with an error:',mp.bgerr,'   |'
 print,' | Use the RIGHT Mouse Button if these are unsatisfactory.          |'
 print,' | Note: all graphical input is performed by placing the cross-hairs |'
 print,' |       at the point of interest and pressing a mouse button.      |'
 print,' ------------------------------------------------------------------'
 ;
 return
 end
 ; ************************  END of MASTER.AUX Package  ***************************
```

```
PRO COMPARE,WW,RS,sdata,mp,mcntrl
;***************************  COMPARE.PRO  *********************************
;
;       TO FIND INTERSTELLAR LINES IN VARIOUS LOOK UP TABLES
;
;           WW       wavelength of feature to be identified
;           RS       red shift (Doppler Velocity Features)
;           sdata    data structure for single measurement
;           mp       MSLAPparameter structure
;
;       Charles L. Joseph          3/28/79        Latest Rev.: 4/5/90
;
;*****************************************************************************
;
    WF=WW/(RS+1.)                                          ; apply the red shift
    nullid = { notdat, el: bytarr(15), iaf: long(0), wl: 0.0, f: 0.0 }
    uid1 = nullid                                          ; Make a "single" entry.
    mids = replicate({ notdat }, 2000)                     ; Make MSLAP LUT array.
    uids = replicate({ notdat }, 200)                      ; Do the same for user's.
    wrk  = replicate({ notdat }, 10)                       ; Make small working
    wrk2 = replicate({ notdat }, 10)                       ;    structures.
    wrk2.wl = -32000.                                      ; Unused ones to odd val.
    close,3
    if (mp.DTY eq 1) OR (mp.DTY eq 3) then $
      openr,3,mcntrl.libr+'/tabdata/ilut.tab'   ; Open LUT file.
    if mp.DTY eq 2 then openr,3,mcntrl.libr+'/tabdata/mlut.tab' ; Open LUT file.
    if mp.DTY eq 4 then openr,3,mcntrl.libr+'/tabdata/qlut.tab' ; Open LUT file.
    readu,3,mids                                           ; Read LUT structure.
    CLOSE,3
    OPENR,3,'ulut.tab', ERROR = errtst                     ; Get User LookUpTable
    if errtst eq 0 then readu,3,uids                       ; if one exists.
    wtst = where(mids.wl le WF, N)                         ; Which is best entry?
    if N le 2 then N = 2
    wrk2(0:4) = mids(N-2:N+2)                              ; Into working structure.

    if mp.DTY eq 3 then begin                              ; If two tables are to be
       close,3                                             ; used, replace strange
       openr,3,mcntrl.libr+'/tabdata/mlut.tab'             ; values with real ones.
       readu,3,mids
       wtst = where(mids.wl le WF, N)                      ; Which is best entry?
       wrk2(5:9) = mids(N-2:N+2)                           ; Stuff into working str.
    endif

    W = wrk2.wl
    for k=0,9 do begin                                     ; Order combined small
wtst = min(W,ibest)                                ; structure according to
        wrk(k) = wrk2(ibest)                               ; wavelength.
W(ibest) = 32000.
    endfor

    W = wrk.wl
    W = abs(W-WF)                                          ; Find absolute diffs.
```

```
    wtst = min(W,ibest)                                    ; ibest is array index.
    if ibest lt 1 then ibest=1
OK: print,' '
;                                                          ;
; ------------ Set up to show choices found in the tables ------------------

   nuids = 0
   USERIDS,WW,NC,WF,nuids,n_names,ns,uid1,uids,mcntrl      ; Any User ID's?
   n_names(0)       = 'Which Entry?'
   n_names(1)       = 'None - Return to Spectra'
;                                                          ; found in user Lookup.
   for k = 0,2 do begin
      uid1 = wrk(ibest-1+k)                                ; Get next entry.
      DD = (WW-uid1.wl)/uid1.wl*299792.5                   ; Convert to velocity.
      AION = string(uid1.el) + ' ................'
      AION = strmid(AION,0,15)
      wk = string(format='(f9.3)',uid1.wl)
      fk = string(format='(f7.4)',uid1.f)
      n_names(k+2) = wk+'  '+string(format='(f6.1)',DD)+'  '+AION+'   f='+fk
   endfor
   n_names(nuids+5) = 'Input Identity'                     ; nuids = # of lines
   print,'Select Look-Up Table Entry    -- Note: None is an option.'
   print,'                              -- 2nd number is the Doppler velocity (km/s).'
   WHICH = wmenu(n_names, title=0,init=3)

   NNN = WHICH - 3
   mp.cntrl = 1
   IF mp.cntrl EQ 0 THEN NNN=0                                    ;
   if (WHICH le 1) then mp.cntrl = 0

;  ------------------- Three sources of input ----------------------------

   if(WHICH EQ (nuids+5)) then begin ; ================ ; Input new ULUT entry.
      NNN = 999
      print,'>>>> Requesting ID <<<<'
      USERIDS,WW,NC,WF,NNN,n_names,ns,uid1,uids,mcntrl
      sdata.el = uid1.el                                  ; Put codes into struct-
      sdata.iaf = uid1.iaf                                ; for MSLAP measurements.
      sdata.wl  = uid1.wl
      sdata.f   = uid1.f
      WL=uid1.wl
      AION = string(uid1.el(0:1))
      MUL = 0
      NNN = 999
   endif
   IF ((NNN GE 2) AND (NNN le 100)) THEN BEGIN ; ========; Get ID from user table
      N = ns(WHICH)
      print,'Using ULUT entry #:',N
      uid1        = uids(N)
      sdata.el    = uid1.el
      sdata.iaf   = uid1.iaf
      sdata.f     = uid1.f
```

```
      sdata.wl    = uid1.wl
      AION = string(uid1.el(0:1))
      MUL=0
      CLOSE,3
   END
   if (NNN lt 2) then begin    ; ********************** ; Get from stndrd LUT.
      ibest = ibest + WHICH - 3                          ; Get requested index.
      if ibest lt 0 then ibest = 0                       ; Make sure range is OK.
      uid1 = wrk(ibest)
      sdata.el  = uid1.el
      sdata.iaf = uid1.iaf                               ; Get ionization state.
      sdata.wl  = uid1.wl
      sdata.f   = uid1.f
   END                                                   ;
   if sdata.iaf lt 0 then print,'sdata.iaf:',sdata.iaf
   if sdata.iaf lt 0 then stop
   CLOSE,2                                               ; Close look up table.

RETURN                                                   ; Go back to DETAILS.
END                                                      ;
;
;
;
;  ************************************************************************
;
;         PROCEDURE USERIDS  to allow the user to identify lines
;
;                  by  Charles L Joseph     13-Aug-84
;
;  ************************************************************************
;
PRO USERIDS,WW,NC,WF,nuids,n_names,ns,uid1,uids,mcntrl
   ncnt = where(uids.wl ne 0., NC)                       ; get # of lines
   W = uids.wl
   if (nuids gt 100) then goto, IDIT                     ; Input identity?

;  ------------- This part searches for existing entries --------------------

   i_names = string(bytarr(26,26))                       ; Big enough to hold max
   ns = intarr(26)                                       ; # of Menu selections.
   for K=0,99 do begin
     IF ABS(W(K)-WF) LT mcntrl.wtol THEN BEGIN           ; Close to that observed?
uid1 = uids(K)
        DB=(WW-W(K))/W(K)*299792.5                       ; Convert to velocity.
AION = string(uid1.el)+' ..............'      ; Start building string
AION = strmid(AION,0,15)                                 ; for the menu selection.
        wk = string(format='(f9.3)',W(K))
        i_names(nuids+5) = wk+'  '+string(format='(f6.1)',DB)
        fk = string(format='(f7.4)',uid1.f)
i_names(nuids+5) = i_names(nuids+5)+'  '+AION+'   f='+fk
        ns(nuids+5)      = K                             ; Store ULUT address.
        nuids = nuids + 1                                ; Increment the counter.
```

```
        if (nuids gt 20) then goto, OUT                ; Can only hold 20 entries
      END
    endfor
OUT:  n_names = i_names(0:nuids+5)                     ; Reduce Menu Selections
close,3                                                ; to the correct size.
RETURN

;  ---------- New entries to the User LookUpTable (LUT) are made here -------

IDIT: print,' '
   print,'Enter Complete Species Name - include ionization and fine structure.'
   print,'Do not leave any preceding blanks.  Enter for example: "Fe II*" for'
   print,'iron singly ionized and excited Fine Structure.  This entry will only'
   print,'be used as an element identifier and print label.  The ionization will'
   print,'have to be entered later.'
   vdum = ''
   read,vdum
   elm=vdum
   uid1.el = 0*uid1.el
   elm = strtrim(elm,1)+' ..............'
   uid1.el = byte(strmid(elm,0,15))
   vdum = ''
   READ,'What is the IONIZATION state  [ 2 = II    4 = IV ] ?',vdum
   IA=fix(vdum)
   vdum = ''
   if IA le 0 then begin                                ; Encode as molecule or
      print,' '
      print,'Species is assumed to be a molecule'
      read,'What is the vibrational level?',vdum
      iaf = 10*fix(vdum)
      vdum = ''
      read,'What is the rotation level? (9 Max)',vdum
      iaf = iaf + fix(vdum)
      vdum = strmid(elm,0,2)
      if (vdum eq 'H2') OR (vdum eq 'HD') then begin
  read,'Enter 1000 if this is part of the Werner system',ly
  if ly eq 1000 then iaf = iaf + 1000
      endif
   endif  ELSE begin                                    ; else encode as ion.
      READ,'What is the FINE STRUCTURE state [ 3 =  *** ] ?',vdum
      FS=fix(vdum)
      iaf = FIX(IA*10 + FS)                             ; Ionization & Fine Str.
   endelse
   READ,'What is the Rest WAVELENGTH of the line ?',vdum
   uid1.wl = float(vdum)                                ; Rest Wavelength.
   READ,'What is the OSCILLATOR strength of the line ?',vdum
   uid1.f = float(vdum)                                 ; Oscillator Strength.

   tst = uid1.el(0:1)  ; ---------------- Encode as Periodic Table & Molecules
   els = 'H HeLiBeB C N O F NeNaMgAlSiP S ClArK CaScTiV CrMnFeCoNiCuZn'
   els = els+'H2H2HDHDCOCHCNC2OHU U U'                  ; Elements + Molecules
   els = byte(els)
```

```
   j = 0
   atst = 0
   while atst eq 0 do begin
 atst = ((tst(0) eq els(j)) AND (tst(1) eq els(j+1)))
 j = j + 2
 if j gt 78 then goto,exitst
   endwhile
exitst: uid1.iaf = long(iaf) + long(1000)*(j/2)          ; Include ionization.
;  ------------------------------------------------------------------------
   CLOSE,2                                               ; close look up table

   ID = ''
   READ,'Enter element permanently in table?',ID
   IF (ID EQ 'y') OR (ID eq 'Y') THEN begin
      uids(NC) = uid1
      close,3
      openr,3,'ulut.tab', ERROR = errtst                 ; See if file exists and
      close,3                                            ; make one if necessary.
      if errtst eq 0 then openu,3,'ulut.tab' ELSE openw,3,'ulut.tab'
      writeu,3,uids                                      ; Update ULUT.
   endif
   CLOSE,3
RETURN
END

PRO POSTO,STAR
;****************************** POSTO.PRO  ***********************************
;
;       To list the measured lines from DETAILS and create ASCII files of
;       this data.
;       by Charles L. Joseph                          December 19, 1980
;                                  Latest Revision: January   7, 1991
;        STAR     file name
;
;*************************************************************************
    LPF=0                                                ; flag to pause for LP
STRT:close,1
    OPENU,1,STAR+'.DTL'                                  ; Open the .DTL file.
nulld = { noda, el: bytarr(15), iaf: long(0), wl: 0., f: 0., owl: 0., eqw: 0., $
   me: 0., fm: 0., fme: 0., sm: 0., sme: 0., com: bytarr(10), up: fltarr(30) }
    dtl  = replicate({ noda }, 200)                      ; Make array for storage
    sdata = nulld                                        ; Make working copy
    readu,1,dtl                                          ; Read the data.
    close,1
    sz = where(dtl.iaf ne 0.)                            ; Get # of measurements
    sz = size(sz)
    if (sz(0) eq 0) then NTL = 0 else NTL = sz(1)        ;     &  store in NTL.
    IF NTL EQ 0 THEN GOTO,EXIT                           ; return if none
LOOP:WTD=0                                               ; set up loop
    spawn,'clear'
    for k=0,3 do print,' '
    print,' ================ Program POSTO.PRO ============================='
```

```
    print,' '
    print,'It is best to resize this window to the full screen while in POST0.'
    print,'This can be done now and a reminder to unzoom the window will appear'
    print,'at the appropriate time.'
    for k=0,4 do print,' '
    PRINT,' Options to MANIPULATE TABLED DATA:'
    PRINT,'   1:   Reorder .DTL file by Laboratory Wavelength'
    PRINT,'   2:   Reorder .DTL file by Observed Wavelength'
    PRINT,'   3:   Reorder .DTL file by Ion (Use Opt 1 or 2 first)'
    PRINT,'   4:   List existing .DTL file'
    PRINT,'   5:   Create Customized  Table in ASCII format'
    PRINT,'            Note: all .DTL files should be reordered'
    PRINT,'                  in the same fashion first.'
    PRINT,'  10:   EXIT - Back to MSLAP'
    print,' '
    READ,'   Which do you want ?',WTD                    ; which one

    IF WTD EQ 10 THEN GOTO,EXIT
    LPF=0                                                ; lots of time for LP
    IF WTD EQ 3 THEN PRINT,'NOTE: It may be necesary to use Option 1 or 2, first'
    IF (WTD GE 1) AND (WTD LE 3) THEN SRT,dtl,WTD,STAR
    IF WTD EQ 4 THEN BEGIN
        PUBL,sdata,dtl,STAR,NTL
        YNO=' '                                          ; want a listing?
        READ,'Press <ENTER> when ready to proceed',YNO
    END
    if WTD eq 5 then begin
       mkcusttab,STAR,dtl                                ; Make Custom Table.
       goto, STRT                                        ; Go re-read orig. data.
    endif
    if WTD lt 6 then goto, LOOP
EXIT: print,string(7B)                                   ; Flash screen.
      print,'Unzoom the this window IF it has been expanded to full screen.'
      yno = ''
      read,'Press the <RETURN> key when ready to continue.',yno
RETURN
END                                                      ;
;
;
PRO SRT,dtl,WTD,STAR
;***************************** SORT.PRO  *********************************
;
;       TO SORT .DTL DATA FILES    by Charles L. Joseph  22-Jan-1980
;
;       dtl         the primary structure holding the measurements of DETAIL.
;       WTD         What-To-Do Flag  1 => sort by Wavelength
;                                    3 => sort by Periodic table then molecules.
;       STAR        name of the file
;
;*************************************************************************
     if WTD eq 1 then begin                              ; Sort by Lab. Wavelength
       nslot = dtl.wl
```

```
      nslot = 10000. - nslot                          ; Ordering is in NSLOT
    endif
    if WTD eq 3 then nslot = dtl.iaf                  ; Sort by Ion => NSLOT
    nslot = (nslot > 0) + 99999.*(nslot eq 0)         ; Flag to ignore null data.
    tdtl = dtl                                        ; Make copy of data.
    kk = 0
    for k = 0,199 do begin                            ; Perform sort from min to
        vy = min(nslot,ky)                            ; max.
        if vy lt 99999. then begin
           tdtl(kk) = dtl(ky)
   nslot(ky) = 99999.
           kk = kk + 1
        endif  else goto, out
    endfor
out: dtl = tdtl
    openu,1,STAR+'.DTL'                               ; Make changes permanent by
    writeu,1,dtl                                      ; writing them to file.
    close,1
RETURN                                                ; back to POSTO
END                                                   ;
;
;
PRO PUBL,sdata,dtl,STAR,NTL
;******************************** PUBL.PRO ********************************
;
;       To print the results for POSTO.
;       By Charles L. Joseph                          November 1980
;
;       sdata       a structure holding the measurements of a single profile.
;       dtl         a structure holding the primary data >> many sdata's.
;       STAR        name of the file
;       NTL         number of measured lines
;
;**************************************************************************

   PHDR='Ion              Lab       f    D-lam    EQW     error     comments'
   N=-1                                               ; counter for pages
   PG=0                                               ; page #
   NT=0                                               ; total counter
   for k=0,4 do print,' '
PAGE: if !d.name eq 'TEK' then erase                  ; start loop  4010
   PG=PG+1                                            ; increment page #
   starp = STAR+'_____________'
   starp = strmid(starp,0,15)
   pgp   = string(format='(i2)',PG)
   PRINT,starp,'                                          Page:',pgp
   PRINT,' '                                          ;
   PRINT,PHDR                              ; page header
    PRINT,FORMAT='(14x,a4,5x,"Value    mA",5x," Eqv Width")'
   PRINT,' '                                          ;  and 2nd line
   NT=NT+44                                          ; # on page
   IF NT GT NTL-1 THEN NT=NTL-1                       ; how many lines ?
```

```
LOOP: N=N+1                                                    ; printout data
   dt = dtl(N)
   AION = string(dt.el)
   COM  = string(dt.com)
   IF N GT NTL-2 THEN NT=45*PG                                 ; for pages
   PLMN = ' +/- '
   PRINT,FORMAT='(A15,1x,F7.2,1x,F7.3,1x,I5,1x,f8.3,1x,f8.3,2x,A10)', $
            AION,dt.wl,dt.f,dt.owl,dt.eqw,dt.me,COM
   IF NT LT 45*PG THEN GOTO, LOOP                              ; don't page yet
   FOR I=0,11 DO PRINT,' '                                     ; move out of the way
   IF N LT NTL-1 THEN GOTO, PAGE                               ; set up new page
   CLOSE,3                                                     ; close .LST up
RETURN                                                         ; back to POSTO
END                                                            ;
;
;
; ***************************************************************************
;  MKCUSTTAB - to make a customized table (ASCII format).
;  by Charles L. Joseph                                        November 29, 1990
; ***************************************************************************
pro mkcusttab,STAR,dtl
   frstim = 1                                                  ; First time flag.
   sdots =''
   for k=1,6 do sdots=sdots+'.........:.........|'             ; Make an axis marker.
   sdots = '|'+sdots                                           ; Index starts at 0.
   dash  = '-----------------------------------------'
   uline = ''
   for k=1,5 do uline = uline+'_____________________'          ; Make long underline.
     mstr = string(bytarr(120,308))                            ; 308 el. string array
;      each el: 120 char.
     miaf = long(intarr(301))+long(99999)                      ; To hold the ID codes.
     vtmp = where(dtl.iaf gt 0,tmax)                           ; Table size -> tmax.
     nstrt = 0                                                 ; Starting line-display.
     if tmax ge 6 then nstp = 5  ELSE  nstp = tmax - 1         ; Stopping line-display.
     NTOT = 36                                                 ; # needed - Species ID.
     L = 0                                                     ; Index for copt.
     copt = intarr(20)                                         ; Column options, a .DTL
     uopt = intarr(20)                                         ; For options of UP.
     upc  = string(bytarr(10,20))                              ; Holds format strings.
     prvopt = ' '                                              ; Holds previous opts.
     spe = '                                              '    ;
     mstr(306) = spe+STAR                                      ; Last few lines of mstr
     mstr(304) = 'Species       Wavelength     f          ' ;  hold header info.
     mstr(303) = '-----------------------------------'
     for k=0,tmax-1 do begin
  sdata = dtl(k)
  spe = string(sdata.el)                                ; Build a string of
  spe = spe+string(format='(f9.2)',sdata.wl)            ;   ID's and assoc. info
  spe = spe+' '+string(format='(f9.4)',sdata.f)+'   '
  mstr(k) = spe                                         ; Put into mstr.
  miaf(k) = sdata.iaf                                   ; Save ID codes.
     endfor
```

```
      wrk = '>>>>>>>>>>>>>>>>>>>>>>>  CUSTOMIZED TABLE WORK SPACE  '
      wrk = wrk+'<<<<<<<<<<<<<<<<<<<<<<<'
      tbl = '>>>>>>>>>>>>>>>>>>>>>>>  Partial Display of the TABLE  '
      tbl = tbl+'<<<<<<<<<<<<<<<<<<<<<<<'
      cnt = ''
      for k=1,6 do cnt = cnt+'12345678901234567890'
      cnt = '0'+cnt
MORE: ; = L + 1                                          ; Incr. options index
      if (tmax-1 gt nstp-nstrt) AND (nstp-nstrt lt 4) then begin
nstp = nstrt + (tmax - 1)
if tmax gt 5 then nstp = nstrt + 5
      endif
      spawn,'clear'                                      ; Erase &
      for k=0,2 do print,' '                             ;
      print,tbl                                          ;   print table header &
      print,' '                                          ;   print part of table.
      for k=0,3 do print,mstr(306-k)                     ;
      for k=nstrt,nstp do print,mstr(k)                  ;
      print,sdots
      print,cnt
      for k=0,3 do print,' '                             ; Then print instructs.
      print,wrk
      print,'First three columns include species name, lab. wavelength, and ', $
      'oscillator strength.'
      NTOT = FIX(NTOT)
      print,'Total number of characters used is:',NTOT,' out of 120 max.'
      print,'Total number of lines in the table:',tmax
      print,' '
      print,'Options for Adding/Subtracting to/from table are:'
      print,' '
      print,'     1) Get new .DTL file'
      print,'     2) Delete character columns'
      print,'     3) Add Observed Wavelengths of current .DTL file'
      print,'     4) Add Equivalent widths of current .DTL file'
      print,'     5) Add Equivalent width ERRORs of current .DTL file'
      print,'     6) Add 1st moments (DOPPLER VELOCITIES) of current .DTL file'
      print,'     7) Add 1st moment ERRORs of current .DTL file'
      print,'     8) Add 2nd moments of current .DTL file'
      print,'     9) Add 2nd moment ERRORs of current .DTL file'
      print,'    10) Add comment field  (Requires 10 characters)'
      print,'    11) Add One of the UPs (UserParameters)'
      print,'    12) Finish - Create file'
      print,' '
      READ,'Enter Option Number',iopt                        ; Input the option #.
      if iopt gt 2 then begin                                ; If iopt > 2 then:
 prvopt = prvopt+' '+string(fix(iopt))                  ;    keep a record &
 copt(L) = iopt                                         ;    store options.
         wup = 0
 if iopt eq 11 then begin                               ; To use a UP option.
    print,'Which element of the UP is to be added?'
    read,'(Enter -1 for none)',wup                      ; Oops, none wanted.
    if wup lt 0 then goto, MORE
```

```
   uopt(L) = wup                                          ; Save choice.
formatin:  print,' '                                                ; Input format.
   print,'Supported Formats are: f, e, & i having a max field of 10.'
   print,'Examples:  (f8.3), (e10.3), (f10.0), (i6)'
   wptc = ''
          read,'Enter format:',wptc
   print,' '
   tst = strpos(wptc,')')                                 ; Parenthesis used?
   if tst eq -1 then print,'Parenthesis must be included',string(7B)
   if tst eq -1 then goto,formatin
   upc(L)  = wptc
        endif
if iopt ne 11 then L = L + 1                              ; Incr. later if UP.
     endif
     if (iopt EQ 1) then begin                                      ; Same cols for new?
print,string(7B),'Old file had options:',prvopt           ; Show previous ones.
yno = ''
read,'Add all of these columns in new .DTL data?',yno
if (yno ne 'Y') AND (yno ne 'y') then begin               ; If not the same,
    tst = 0                                               ;   find out which
    kst = 0                                               ;   ones.
    icnt = 0
    print,'Sequentially enter each option for next .DTL file'
    print,'Enter -1 when finished'
    while tst ge 0 do begin                               ; Get options desired
       read,'Enter next option',tst
       if tst gt 2 then copt(icnt) = tst
       if tst gt 2 then icnt = icnt + 1
              wup = 0
       if iopt eq 11 then begin                           ; To use a UP option.
          read,'Which element of the UP is to be added?',wup
          uopt(icnt) = wup                                ; Save choice.
          print,'Formats are: f, e, & i having a max field of 10.'
          print,'Examples:  (f8.3), (e10.3), (f10.0), (i6)'
          wptc = ''
                 read,'Enter format:',wptc
          upc(icnt)  = wptc
               endif
       if icnt gt 0 then L = icnt                         ; New master count.
            endwhile
    if icnt gt 0 then begin
       copt(icnt:19) = 0                                  ; Catch any stray
       uopt(icnt:19) = 0                                  ; left overs from
       upc(icnt:19)  = ''                                 ; from before.
              prvopt = ''
       for k=0,icnt-1 do prvopt=prvopt+string(copt(k))
    endif
    if icnt eq 0 then goto, MORE                          ; No choices - abort.
endif
vtmp = mstr(306)
ssz = strlen(vtmp)
if (ssz gt NTOT+4) then vtmp = strmid(vtmp,0,NTOT+3)+'__'
```

```
mstr(306) = vtmp
appnd,dtl,mstr,miaf,copt,uopt,upc,NTOT,tmax          ; Get new .DTL info.
     endif
     if iopt eq 2 then begin                                  ; Delete some columns
print,'Which character columns are to be deleted?'   ; of characters.
read,'Enter starting and ending columns',c1,c2
for k=0,307 do begin
    tst = mstr(k)
          tst = strmid(tst,0,c1-1)+strmid(tst,c2,120-c2)
    mstr(k) = tst
        endfor
NTOT = FIX(NTOT - (c2-c1) - 1)                       ; Adjust counter.
     endif
     if (iopt GE 3) AND (iopt LE 11) then begin           ; Add an entry.
 if iopt eq 11 then begin                            ;   UP option.
     wup = uopt(L)
     upf = upc(L)
     L   = L + 1                                     ;   Still Needs incr.
 endif
 for k=0,199 do begin
     sdata = dtl(k)
     nextstring,iopt+2,nstrg,stitl,strsz,sdata,wup,upf
     mstr(k) = mstr(k)+'  '+nstrg
         endfor
 ssz = 0
 if frstim then begin                                ; If first time, then
    ssz = strlen(STAR)                               ; adj. character size
    if (ssz gt strsz+2) then ssz=strsz+2             ; accordingly.
    frstim = 0                                       ; No longer first.
 endif
 mstr(306) = mstr(306)+strmid(uline,0,strsz+2-ssz)   ; Adj. to file name
 mstr(304) = mstr(304)+stitl                         ; + new column names
 mstr(303) = mstr(303)+strmid(dash,0,strsz+2)        ; + more dashed line.
 NTOT = NTOT + strsz + 2                             ; Adjust counter.
     endif
     if (iopt lt 12) then goto, MORE
Outfile: vtmp = ''
     read,'Enter file name of the table: (type: "none" for no file) ',vtmp
     if (vtmp ne 'none') AND (vtmp ne 'NONE') then begin
        close,1
        openr,1,vtmp, ERROR = errtst
        close,1
        if errtst eq 0 then begin
   yno = ''
   read,'File already exists.  Try another? ',yno
   if (yno eq 'Y') OR (yno eq 'y') then goto, Outfile
        endif
        openw,1,vtmp
 wrk = mstr(306)
 mstr(306) = strmid(wrk,0,NTOT)
        for k=0,3 do printf,1,mstr(306-k)                ; Top of table.
        for k=0,tmax-1 do printf,1,mstr(k)               ; Table entries.
```

```
printf,1,mstr(303)                                    ; 2nd dash line.
        close,1
     endif

RETURN
END ; mkcusttab
;
;
; ***************************************************************************
;  APPND is used by MKCUSTTAB to append additional data files to the
;  customized table.
;               by Charles L. Joseph                Dec. 1, 1990
;
;        dtl     structure holding the contents of the .DTL file
;        mstr    an array of character strings holding the master data
;        miaf    master iaf used to slot the appended file
;        jcnt    the counter pointing to entry in the dtl structure.
;                    for example, 3 =>
;  ***************************************************************************
pro appnd,dtl,mstr,miaf,copt,uopt,upc,NTOT,tmax

STRT: ndtl = ''                                       ; Next .DTL filename.
   nnew = 0                                           ; No-New Counter.
   nold = 0                                           ; No-Old Counter.
   read,'Enter new .DTL file name (leave off .DTL extension): ',ndtl
   close,1
   openr,1,ndtl+'.DTL', ERROR = errtst                ; Does file exist?
   close,1
   if errtst ne 0 then begin                          ; If file NOT pres.
      yno = ''
      read,'Error opening file -- try another?',yno   ; Try again?
      if (yno eq 'Y') OR (yno eq 'y') then goto, STRT ; Yes, get another or
      return                                          ;      else return.
   endif
   openu,1,ndtl+'.DTL'                                ; Open the .DTL file.
   readu,1,dtl                                        ; Read the data.
   close,1                                            ; Close the .DTL file.
   niaf = dtl.iaf                                     ; Get species codes.
   vtmp = where(niaf ne 0,ktst)                       ; How many --> ktst.
   niaf = 99999*(niaf eq 0) + niaf                    ; Set all 0's -> 99999
   dtl.iaf = niaf
   sdots = '.........................................' ; Make a dummy filler
   sdots = sdots+'.....................................' ;      string.
   sdots = sdots+'.....................................' ;
   dash = '-----------------------------------------' ; To continue dash.
   vtmp = where(copt gt 0,L)                          ; Find L=# of options.
   k  = 0                                             ; Index for new data.
   kk = 0                                             ; Index for old data.

 Next: if k gt 199 then return
   sdata = dtl(k)                                     ; Get next line of new
   iafnxt = sdata.iaf                                 ; Next species code.
```

```
   vtmp = 0
   tmpstr = ''
   tmptit = ''
   for lcnt=0,L-1 do begin                                  ; Get all entries for
       jcnt = copt(lcnt)+2                                  ;     next species.
       wup  = uopt(lcnt)                                    ; In case UP get info-
       upf  = upc(lcnt)                                     ;     mation & format.
       nextstring,jcnt,nstrg,stitl,strsz,sdata,wup,upf      ; Entry --> string.
       tmpstr = tmpstr+'  '+nstrg                           ; Build up all entries
       tmptit = tmptit+stitl
       vtmp   = vtmp + strsz + 2
   endfor
   nstrg = tmpstr                                           ; Put accumulation
   stitl = tmptit                                           ;    variables into
   strsz = vtmp                                             ;    permanent ones.
Loop: iaftst = miaf(kk)                                     ; Get next line of old
   if iafnxt eq iaftst then begin                           ; If species agree:
      mstr(kk) = mstr(kk)+nstrg                             ;    - add on
      kk = kk + 1                                           ;    - increment each
      k  = k + 1                                            ;      counter &
      if (k lt ktst) OR (kk lt tmax) then goto, Next    ;    - Any more?
   endif
   if iafnxt gt iaftst then begin                           ; Missing line of new.
      nnew = nnew + 1
      mstr(kk) = mstr(kk)+'  '+strmid(sdots,0,strsz-2)      ; Fill entry with dots
      kk = kk + 1                                           ; Set index to get
      goto, Loop                                            ;    next line of old.
   endif
   if (iafnxt ne 0) AND (iafnxt lt iaftst) then begin       ; New entry not in old
      nold = nold + 1
      for n=kk,299 do miaf(300+kk-n) = miaf(299+kk-n)       ; Shift to make room.
      for n=kk,299 do mstr(300+kk-n) = mstr(299+kk-n)       ; Shift to make room.
      miaf(kk) = sdata.iaf                                  ; Add species code.
      mstr(kk) = ''                                         ; In case new << old.
      spe = string(sdata.el)                                ; Build a string of
      spe = spe+string(format='(f9.2)',sdata.wl)            ;   ID's and assoc.
      spe = spe+'  '+string(format='(f9.4)',sdata.f)+'  '   ;   information plus
      spe = spe+strmid(sdots,0,NTOT-36)                     ;   fill in dots.
      mstr(kk) = spe                                        ; Add new entry.
      tmax = tmax + 1                                       ; Table has 1 more.
      goto, Loop                                            ; Should = next time.
   endif

Fin: uline = ''
   for k=1,5 do uline=uline+'----------'
   ndtl = ndtl+uline
   mstr(306) = mstr(306)+strmid(ndtl,0,strsz)               ; 2s added to strsz
   mstr(304) = mstr(304)+stitl                              ; before.
   mstr(303) = mstr(303)+strmid(dash,0,strsz)
   NTOT = NTOT + strsz                                      ; Incr. column count.
   print,'# of blank lines in OLD:',nold,'   in NEW:',nnew
```

```
RETURN
END
;
;
; ***************************************************************************
;  NEXTSTRING is used to get the size and the conversion to string of the
;  next set of entries to be put in the table.  Called by APPND or MKCUSTTAB.
;        by Charles L. Joseph                              November 1990
;
;        jcnt     the index of the requested portion of the sdata structure.
;                     (see the manual for the sdata or dtl structures.)
;        nstrg    the returned Next String
;        stitl    the title of the entry  (e.g. EQW, ERROR, 1st MOM., etc.)
;        strsz    string size, the number of columns required for the next entry.
;        sdata    a structure holding the measurements for a single profile.
;        wup      Which User Parameter requested  <-- only if jcnt = 13
;        upf      Holds the format if a UserParameter is requested.
; ***************************************************************************
pro nextstring,jcnt,nstrg,stitl,strsz,sdata,wup,upf

   nstrg = ''
   stitl = ''
   strsz = 0
   if jcnt eq  5 then nstrg = string(format='(f8.2)',sdata.owl)
   if jcnt eq  5 then stitl = 'Obs. Wave.'
   if jcnt eq  6 then nstrg = string(format='(f8.4)',sdata.eqw)
   if jcnt eq  6 then stitl = '  EQW (A) '
   if jcnt eq  7 then nstrg = string(format='(f8.4)',sdata.me )
   if jcnt eq  7 then stitl = '   ME (A) '
   if jcnt eq  8 then nstrg = string(format='(f8.2)',sdata.fm )
   if jcnt eq  8 then stitl = '  1st MOM.'
   if jcnt eq  9 then nstrg = string(format='(f8.2)',sdata.fme)
   if jcnt eq  9 then stitl = '   ERROR  '
   if jcnt eq 10 then nstrg = string(format='(f8.3)',sdata.sm )
   if jcnt eq 10 then stitl = '  2nd MOM.'
   if jcnt eq 11 then nstrg = string(format='(f8.3)',sdata.sme)
   if jcnt eq 11 then stitl = '   ERROR  '
   if jcnt eq 12 then nstrg = string(sdata.com)+'.........'
   if jcnt eq 12 then nstrg = strmid(nstrg,0,10)
   if jcnt eq 12 then stitl = '  Comments '
   if jcnt eq 13 then begin                                  ; From UP array.
      val   = strpos(upf,'f')                                ; Floating format?
      if val eq -1 then val = strpos(upf,'F')                ; Floating format?
      if val eq -1 then val = strpos(upf,'i')                ; Integer format?
      if val eq -1 then val = strpos(upf,'I')                ; Integer format?
      if val eq -1 then val = strpos(upf,'e')                ; Exponential format?
      if val eq -1 then val = strpos(upf,'E')                ; Exponential format?
      if val eq -1 then return                               ; Can't find format.
      strsz = strpos(upf,'.')                                ; Find end of format.
      if strsz eq -1 then strsz = strpos(upf,')')            ; If no dot.
      strsz = fix(strmid(upf,val+1,strsz-1))                 ; String size.
      val = sdata.up                                         ; UP array -> val.
```

```
      val = val(wup)                                          ; Get array element.
      nstrg = string(format=upf,val)+'         ..'           ; Use format in upf.
      if strsz lt 6 then nstrg = '    '+nstrg                 ; Pad with 4 blanks?
      nstrg = strmid(nstrg,0,10)                              ; Make 10 characters.
      stitl = '  < UP'+string(format='(i2)',wup)+' >  '       ; Make column title.
   endif
   if jcnt ge 12 then strsz = 10  ELSE  strsz = 8             ; # of characters.

RETURN
END
; ********************** END of POSTO PACKAGE ***********************************

;***************************** EDATDTL.PRO ***********************************
;
;  To edit the .DTL files created by the Modular Spectral Line Analysis Program
;
;       by Charles L. Joseph                                  6/12/84
;       Latest Revision:                                      8/10/90
;
;*****************************************************************************
pro edatdtl,star

nulld = { noda, el: bytarr(15), iaf: long(0), wl: 0., f: 0., owl: 0., eqw: 0., $
   me: 0., fm: 0., fme: 0., sm: 0., sme: 0., com: bytarr(10), up: fltarr(30) }
   dtl = replicate({ noda }, 200)                          ; Make array for storage
   sdata = nulld                                           ; Make working copy.
   close,1
   OPENR,1,STAR+'.DTL', ERROR = errtst                     ; Check if file exists.
   close,1
   if errtst ne 0 then begin                               ; If no file, make one.
      close,1
      openw,1,STAR+'.DTL'
      writeu,1,dtl
      close,1
   endif
   openu,1,STAR+'.DTL'                                     ; Open file for updating.
   readu,1,dtl                                             ; Read data file.

   plotconfig,0,' ',' ',-2,kdev,''                         ; Set Hardware defaults.
;  kdev = getenv('TERM')
   if kdev eq 'xterm' then set_plot,'X'
   window,0,color=2,title=' ',xpos=760,ypos=300,xsize=380,ysize=300
   !y.margin(0) = 2                                        ; This window for print-
   plot,findgen(10)                                        ; ing Reminders.
   if kdev ne 'xterm' then x0 = -0.25*(!x.crange(1)-!x.crange(0)) + !x.crange(0)
   if kdev eq 'xterm' then x0 = 0.0*(!x.crange(1)-!x.crange(0)) + !x.crange(0)
   yo = 0.5*(!y.crange(1)-!y.crange(0))
   y0 = !y.crange(0)
   erase
   for k=0,2 do print,' '
   print,'   >>>>  EDITING the .DTL File  <<<<'            ; Send Reminders to
   for k=0,2 do print,' '                                  ; extra window.
```

```
   xyouts,x0,2.0*yo+y0,'-------Editing Reminders--------'
   xyouts,x0,1.8*yo+y0,'<CR> or n  -  goto NEXT entry'
   xyouts,x0,1.6*yo+y0,'          u  -  go UP to prev. entry'
   xyouts,x0,1.4*yo+y0,'          c  -  change current entry'
   xyouts,x0,1.2*yo+y0,'          i  -  insert new data'
   xyouts,x0,1.0*yo+y0,'          d  -  delete current entry'
   xyouts,x0,0.8*yo+y0,'          t  -  goto TOP of data'
   xyouts,x0,0.6*yo+y0,'          b  -  goto BOTTOM of data'
   xyouts,x0,0.4*yo+y0,'     k or q  -  Kill/Quit'
   xyouts,x0,0.2*yo+y0,'          w  -  Write (Update) File'
   xyouts,x0,0.0*yo+y0,'          e  -  Exit and write changes'

START:  ML= 200                                          ; Maximum # of measures.
A = where(dtl.wl ne 0.0,NTL)
if (NTL le 0) then NTL = 1                          ; Null data set ?
s1 = '  IAF Code:'   &   s2 = '  Rest Wave:'   &   s3 = '  f:'
s4 = '  Obs:'        &   s5 = 'EQW:'           &   s6 = '  Error:'
s7 = '   1st Mom:'   &   s8 = '   2nd Mom:'

TOP:    N = -1
LOOP:   N=N+1                                            ; Each time through,
dt = dtl(N)                                         ; print new line of data.
        AION = string(dt.el)
        print,FORMAT='(a15,a11,i6,a12,f9.3,a4,f6.4,a6,f9.3)', AION,s1, $
      dt.iaf,s2,dt.wl,s3,dt.f,s4,dt.owl
        print,FORMAT='(15x,3(a12,f9.4))', s5,dt.eqw,s7,dt.fm,s8,dt.sm
        print,FORMAT='(15x,3(a12,f9.4))', s6,dt.me,s6,dt.fme,s6,dt.sme
print,'                    Comment: ',string(dt.com)
print,' '
print,'UserParameters'
print,dt.up
        A=''
        READ,A                                           ; Read keyboard option.
        A=BYTE(A)
        A=A(0)
if (A gt 90) then A = A - 32                        ; To handle lower case.
        IF ((A LE 13) OR (A EQ 78)) THEN GOTO,LOOP      ; <CR>  N   Next line
        IF (A EQ 67) THEN BEGIN                         ;  C    - correction
     sdata = dtl(N)                                     ;       Set defaults
           getsdata,sdata,N,A                           ;           Get Updates
           dtl(N) = sdata                               ;           Insert in dtl
     N = N - 1                                          ;       Adj. Pointer
        END
        IF (A EQ 69) OR (A EQ 87) THEN GOTO,DONE        ;  E  W  Exit/Write
        IF A EQ 83 THEN STOP                            ;  S     Stop
        IF (A EQ 72) OR (A EQ 83) THEN N=N-1
        IF A EQ 85 THEN BEGIN                           ;  U     Up one line,
                N=N-2                                   ;       Adj. Pointer
                IF N LT -1 THEN  BEGIN                  ;       Top of File?
                   N=-1
                   PRINT,'TOP OF FILE',STRING(7B)
                END
```

```
        END
        IF A EQ 84 THEN GOTO,TOP                        ; T     Goto Top of file
        IF A EQ 66 THEN N=NTL-2                         ; B     Goto Bottom
        IF (A EQ 75)OR (A EQ 81) THEN GOTO,KILL         ; K  Q  Kill/Quit
        IF (A EQ 68) then begin                         ; D     Delete Line
   dtl(N) = dtl(N+1:ML-1)
   dtl(ML-1) = nulld
   NTL = NTL - 1                                ;       Adj. Number tot.
   endif
if (A EQ 73) THEN BEGIN                         ; I     Insert Line.
          dtl(N+1) = dtl(N:ML-2)                ;       Make room in dtl
          getsdata,sdata,N,A                    ;       Get new line.
   dtl(N)   = sdata                             ;       Insert in dtl.
   N = N - 1                                    ;       Adj. Pointer
   NTL = NTL + 1                                ;       Adj. Number tot.
        END
        GOTO,LOOP
DONE:   close,1
        OPENU,1,STAR+'.DTL'
writeu,1,dtl                                    ; Write changes to .DTL
        IF A EQ 87 THEN GOTO,TOP                        ; Just a write "W" go on.
KILL:   ;                                               ; Abort - Make no changes.
EXIT:   CLOSE,1                                         ; Close .DTL file.
wdelete,0                                       ; Remove extra window.
END
;
;
;
pro getsdata,sdata,N,wtd
;*************************** getsdata.pro ***********************************
;
;   Gets new single-line of data (sdata) for the .DTL file from the keyboard.
;   If "wtd" eq 67 => make a correction.  Then previous data is taken as the
;   default values.
;
;       By Charles L. Joseph                                    8/10/90
;       Latest Revision:                                        8/10/90
;
;*****************************************************************************

   if wtd eq 67 then begin                              ; C - corrections
      print,string(7B)
      print,'Existing data will be taken as the Default Values in the'
      print,'following questions.'
   endif
   print,' '
   print,'Enter Complete Species Name - include ionization and fine structure.'
   print,'15 characters maximum and DO NOT leave any preceeding blanks.'
   print,'Enter for example:'
   print,'      Fe II*  --- for iron singly ionized and excited Fine Structure'
   print,'      H2 L 7,0 P(5) -- Lyman system of molecular Hydrogen'
   print,' '
```

```
if wtd eq 67 then print,'Default:',string(sdata.el)
vdum = ''
read,vdum
if (vdum eq '') AND (wtd eq 67) then elm=string(sdata.el) else elm=vdum
sdata.el = 0*sdata.el
elm = strtrim(elm,1)+' ..............'
sdata.el = byte(strmid(elm,0,15))

iafsv = long(sdata.iaf)
iaf   = long(sdata.iaf) - long(1000)*FIX(sdata.iaf/1000)
iaf   = FIX(iaf)
vdum = ''
if wtd eq 67 then print,'Default:',iaf/10
print,'What is the IONIZATION state  [ 2 = II    4 = IV ] ?
read,'If a molecule, then what is the VIBRATION number? ',vdum
if (vdum eq '') AND (wtd eq 67) then IA=iaf/10 else IA=fix(vdum)
vdum = ''
if wtd eq 67 then print,'Default:',iaf-10*(iaf/10)
print,'What is the FINE STRUCTURE state [ 3 =  *** ] ?'
read,'If a molecule, then what is the ROTATION number? ',vdum
if (vdum eq '') AND (wtd eq 67) then FS=iaf-10*(iaf/10) else FS=fix(vdum)
iaf=FIX(IA*10 + FS)
vdum = strmid(elm,0,2)
if (vdum eq 'H2') OR (vdum eq 'HD') then begin
   ly = ''
   read,'Is this part of the Werner system',ly
   if (ly eq 'y') OR (ly eq 'Y') then iaf = iaf + 1000
endif

if wtd eq 67 then print,format='(a8,f10.3)','Default:',sdata.wl
READ,'What is the Rest WAVELENGTH of the line (Angstroms)?',vdum
if (vdum ne '') OR (wtd ne 67) then sdata.wl = float(vdum)

if wtd eq 67 then print,'Default:',sdata.f
READ,'What is the OSCILLATOR stength of the line ?',vdum
if (vdum ne '') OR (wtd ne 67) then sdata.f = float(vdum)

if wtd eq 67 then print,format='(a8,f10.3)','Default:',sdata.owl
READ,'What is the OBSERVED WAVELENGTH of the line (Angstroms)?',vdum
if (vdum ne '') OR (wtd ne 67) then sdata.owl = float(vdum)

if wtd eq 67 then print,'Default:',sdata.eqw
READ,'What is the EQUIVALENT WIDTH (Angtroms) of the line ?',vdum
if (vdum ne '') OR (wtd ne 67) then sdata.eqw = float(vdum)

if wtd eq 67 then print,'Default:',sdata.me
READ,'What is the ERROR of the measurement ?',vdum
if (vdum ne '') OR (wtd ne 67) then sdata.me = float(vdum)

if wtd eq 67 then print,'Default:',sdata.fm
read,'What is the First Moment (Velocity  km/s) ?',vdum
if (vdum ne '') OR (wtd ne 67) then sdata.fm = float(vdum)
```

```
 if wtd eq 67 then print,'Default:',sdata.fme
 read,'What is the ERROR in the First Moment ?',vdum
 if (vdum ne '') OR (wtd ne 67) then sdata.fme = float(vdum)

 if wtd eq 67 then print,'Default:',sdata.sm
 read,'What is the Second Moment (km/s/s)?',vdum
 if (vdum ne '') OR (wtd ne 67) then sdata.sm = float(vdum)

 if wtd eq 67 then print,'Default:',sdata.sme
 read,'What is the ERROR in the Second Moment ?',vdum
 if (vdum ne '') OR (wtd ne 67) then sdata.sme = float(vdum)

 if wtd eq 67 then print,'Default:',string(sdata.com)
 read,'Comments on Measurement (Up to 10 characters) ?',vdum
 if (vdum eq '') AND (wtd eq 67) then com=string(sdata.com) else com=vdum
 sdata.com = 0*sdata.com
 com = strtrim(com,1)+'          )'
 sdata.com = byte(strmid(com,0,10))

 vdum = ''
 print,' '
 if wtd ne 67 then sdata.up = 0.*sdata.up
 read,'Stop to change UserParameters?  (Y/N   Default is N)',vdum
 print,' '
 if (vdum eq 'y') OR (vdum eq 'Y') then begin
    up = sdata.up
    print,'The UserParameter is a 30 point floating array.'
    print,'The program has stopped and values may be entered interactively.'
    print,'For example: the statement "up(2) = 31.", puts 31 in the'
    print,'             third element of the array.'
    print,'Note: the addresses range from 0 to 29.'
    print,'The command: ".con <Return>" must be entered when finished."
    stop
    sdata.up = up
 endif

;  --------------  Encode as Periodic Table/Molecules ------------------

   tst = byte(strmid(elm,0,2))
   els = 'H HeLiBeB C N O F NeNaMgAlSiP S ClArK CaScTiV CrMnFeCoNiCuZn'
   els = els+'H2H2HDHDCOCHCNC2OHUiUiUi'            ; Elements + Molecules.
   els = byte(els)
   j = 0
   atst = 0
   while atst eq 0 do begin                        ; Search for its order.
 atst = ((tst(0) eq els(j)) AND (tst(1) eq els(j+1)))
 j = j + 2
 if j gt 78 then goto,exitst
   endwhile
exitst: sdata.iaf = long(iaf) + long(1000)*(j/2)    ; Include ionization.
RETURN
```

```
END

pro mantau,STAR,date
;******************************** MANTAU.PRO ********************************
;
;  By Charles L. Joseph                                    June, 1990
;
;  To manipulate the flux, wavelength, continuum, and optical-depth vectors.
;
;
;****************************************************************************

   HC   = 0                                                ; HardCopy Flag = NO.
   MKA  = 0                                                ; Make ASCII Flag = NO.
   kcnt = 0                                                ; File access counter.
   kdev = getenv('TERM')                                   ; Get terminal type.
   tas = assoc(5,fltarr(2,600))                            ; For random disk access.
   ebtst = 0                                               ; No error bars plotted.
   cnct  = 1                                               ; Connect the dots plot.
   vshft = 0.

for k=0,4 do print,' '
print,' ------------------------------------------------------------------------'
print,' | The basic philosophy of this routine is as follows.  The researcher  |'
print,' | selects either new species or new profiles to be examined.  For each |'
print,' | selection, there are options as to how the data will be displayed.   |'
print,' | Plotting options affect the current and all subsequent data.  Thus,  |'
print,' | changes in the display style from one profile to the next should be  |'
print,' | imposed after the profile has been selected.                         |'
print,' ------------------------------------------------------------------------'
print,' '

   getrdy,STAR,niaf,rwav,lwfs,bgs,bge,n_opt,c_opts,s_opt,ctd_opt,iafb4,knone

   aax = [0.,0.,-0.25,0.,0.25]                             ; Values for an arrow
   aay = [0.,3.0,2.6,3.0,2.6]                              ;   (Lower Limit).
STRT:   wtd = wmenu(c_opts,title=0,init=1)                 ; Input What-To-Do Flag
if wtd eq 4 then stop                                 ; Stop - Temporary Halt.
if wtd eq 4 then goto, STRT                           ;      - Start again.
if wtd eq 7 then begin                                ; Toggle plot error bars.
           vtmp = ebtst
           if vtmp eq 0 then ebtst = 1                      ; Plots to have errors.
           if vtmp eq 1 then ebtst = 0                      ; Stop plotting errors.
           if ebtst eq 1 then c_opts(7) = 'Toggle Error Bars OFF'
           if ebtst eq 0 then c_opts(7) = 'Toggle Error Bars ON'
   goto, STRT                                         ; Go start again.
        endif
        if wtd eq 8 then begin                              ; Diff. Connect-Dots?
           tcnct = wmenu(ctd_opt,title=0,init=1)            ; Get choice.
           if (tcnct le 0) OR (tcnct gt 3) then goto, STRT ; Silly choice-ignore.
           cnct = tcnct-1                                   ; Set current status.
   if cnct eq 2 then ebtst = 0                        ; Line only => No errors.
```

```
          if obtst eq 0 then c_opts(7) = 'Toggle Error Bars ON'
   goto, STRT                                        ; Go start again.
        endif
if wtd eq 9 then begin
   print,string(7B),''                               ; Ring the BELL.
   print,'Move cursor to this work area'
   read,'and enter velocity offset (km/s):',vshft
   goto, STRT                                        ; Go start again.
        endif
if wtd eq 11 then begin
          userprog5,STAR,niaf,rwav,lwfs,bgs,bge,tau,kcnt ; Call user's program
   goto, STRT
endif
if (wtd lt 1) OR (wtd ge 12) then goto,EXIT      ; Exit Options.
if wtd gt 2 then wtd = 2                         ; Temp. void options.
        symnum = intarr(19)                             ; Zero plot symbol table
snum   = intarr(19)                              ; Zero species table.
lnum   = intarr(19)                              ; Zero profile table.
ksav   = intarr(19)                              ; To save record #'s.
pleb   = intarr(19)                              ; Plot which Error Bars?
cplt   = intarr(19)                              ; For Connect-dots plot.
vs     = fltarr(19)                              ; For velocity shifts.
spei   = string(80)                              ; For window label.

START:  ; ------------ Starting place for 1st species -----------------------
L = 0   &   H = 0                                ; Auto Plot ranges.
B = 0   &   T = 0
        INUM = 0                                        ; Initialize Image Number
if (wtd eq 1) OR (wtd eq 2) then begin           ; Start with 1st data.
          which = wmenu(n_opt,title=0,init=1)           ; Get species choice.
   if which eq knone then goto, EXIT             ; Choice: "No More".
   snum(INUM)   = which                          ; Save Species Number
   iaf = iafb4(which)
   spei = '...                                '+n_opt(which)
   plotconfig,0,spei,' ',0,kdev,'large'          ; Open type 0 window.
        endif

;  ---------- Next Get, Header, Optical Depths + Spectra  -----------------

LOOP: ;

   lch = 1                                                ; Just in case no choices
   ncnt = where(niaf eq iaf)                              ; Find all matches.
   sz = size(ncnt)                                        ; Total # in sz(1).
   if sz(0) eq 0 then goto, BRNCH                         ; Problem, No Match.
;  if sz(1) eq 1 then kcnt = fix(ncnt(0))                 ; Only one profile.
   if sz(1) ge 1 then begin                               ; Several profiles of the
      l_choice = string(bytarr(22,sz(1)+2))               ;   same species setup to
      l_choice(0) = 'Which Line?     Log fW'              ;   make a selection.
      l_choice(sz(1)+1) = 'None'
      for k=1,sz(1) do begin                             ; For each profile:
  swav = string(format='(f8.3)',rwav(ncnt(k-1)))  ;   -list rest wavelen.
```

```
   slwf = string(format='(f5.3)',lwfs(ncnt(k-1)))  ;   -list log f-lambda.
   l_choice(k) = swav+'       '+slwf               ;   -put into MENU.
      endfor
      lch = wmenu(l_choice,title=0,init=1)                ; Get MENU profile choice
      if (lch le 0) OR (lch ge sz(1)+1) then goto, BRNCH  ; Not valid selection.
      kcnt = ncnt(lch-1)                                  ; Put choice into variab.
   endif
   lnum(INUM) = lch                                       ; Store profile number.
   ksav(INUM) = kcnt                                      ; Store for later plots.
   if cnct ne 2 then symnum(INUM) = wmenu(s_opt,title=0,init=1)  ; Symbol choice?
   if symnum(INUM) eq 9 then begin                        ; Line ONLY:
      cnct = 2                                            ;       => Set to Line.
      ebtst = 0                                           ;       => No errors.
     if ebtst eq 0 then c_opts(7) = 'Toggle Error Bars ON' ;  => Reset Menu opt.
   endif
   if ebtst then pleb(INUM) = 1  ELSE  pleb(INUM) = 0
   cplt(INUM) = cnct
   vs(INUM)   = vshft

;  -------------------- Read & Plot Optical Depths -------------------------

PLT:  asy = findgen(16)*(!PI*2/16.)                    ; Used for plot symbol.
   if HC then plotconfig,1,' ',' ',-1,kdev,''          ; Config. for Hardcopy?

   for k=0,INUM do begin
      kcnt = ksav(k)
      close,5
      openr,5,STAR+'.TAU'
      tautmp = fltarr(2,600)                           ; Make temporary array.
      tautmp = tas(3*kcnt+1)                           ; Get wavelength & TAUs(-).
      sz = TOTAL(tautmp(0,*) ne 0)                     ; Find the length.
      tau = fltarr(6,sz)                               ; Make suitable TAU array &
      tau(0:1,0:sz-1) = tautmp(0:1,0:sz-1)             ; stuff Wavelength & TAUs(-)
      tautmp = 0.*tautmp                               ; Zero temporary array.
      tautmp = tas(3*kcnt+2)                           ; Get TAUs and TAUs(+) &
      tau(2:3,0:sz-1) = tautmp(0:1,0:sz-1)             ;      put into TAU array.
      tautmp = 0.*tautmp                               ; Zero temporary array.
      tautmp = tas(3*kcnt+3)                           ; Get Spectrum & Continuum
      tau(4:5,0:sz-1) = tautmp(0:1,0:sz-1)             ;      and put into TAU.
      ttmp = where(tau(2,*) gt 1.0,tcnt)               ; Which are limits?
      mtmp = where(tau(3,*) gt 1.0,mcnt)               ; Which are limits?
      close,5

      lwf_fact = 14.567 - lwfs(kcnt)                   ; Convert to Column Density.
      tau(1:3,*) = tau(1:3,*) + lwf_fact
      swav = string(format='(f8.3)',rwav(kcnt))        ; Rest wavelength string.

      if MKA eq 1 then begin                           ; IF Make ASCII file.
   slwf = string(format='(f6.3)',lwfs(kcnt))   ;     <-- log f-lambda.
   print,swav+'     log f-lambda: '+slwf+'        '+n_opt(snum(k))
   printf,1,swav+'     log f-lambda: '+slwf+'        '+n_opt(snum(k))
   sbg  = string(format='(f9.1)',bgs(kcnt))    ;     <-- Background.
```

```
sbge = string(format='(f9.1)',bge(kcnt))    ;     <-- BG Error.
printf,1,'Background: '+sbg+'      BG Error: '+sbge
printf,1,' '
printf,1,'Wavelength   log N(min)   log N    log N(max)  Spect.     Cont.'
for kt=0,sz-1 do printf,1,format='(f9.3,5f11.2)', $
    tau(0,kt),tau(1,kt),tau(2,kt),tau(3,kt),tau(4,kt),tau(5,kt)
       printf,1,' '
     endif

     if vshft ne 0. then begin
print,string(7B),''
print,'Caution: profile shifting should seldom be done'
print,'         and then only with extreme care.'
       print,'The '+swav+ 'profile has been shifted by:',vshft,' km/s.'
     endif
     v0 = 2.9979e5/rwav(kcnt)
     v  = v0*(tau(0,*)- rwav(kcnt)) + vs(k)          ; Calculate velocity.

     if symnum(k) eq 3 then begin                    ; Make special symbols?
usersym,0.7*cos(asy),0.5*sin(asy),/FILL      ; Convert dots to filled
tsym = 8                                     ; circles.
     end else begin
        usersym,0.7*cos(asy),0.5*sin(asy)            ; Option for open circles.
        tsym = symnum(k)                             ; Most cases, take IDL's.
if tsym eq 9 then tsym = 0                   ; Solid line option.
     endelse
     ymsav = !y.margin(0)                            ; Just in case HC = 1, be
     yht = 0.22 - 0.04*k                             ;    ready to make a key.
                                                     ; If cplt(k)=2 -> LINE
                                                     ;           =1 -> LINE+DOTS.
     if (k eq 0) AND (cplt(k) lt 2) then begin       ;           =0 -> DOTS.
if (H ne 0) OR (B ne 0) OR (L ne 0) OR (T ne 0) then begin
          plot,v,tau(2,*),xtitle='velocity',ytitle='log N',psym=tsym,/YNOZ, $
xrange=[L,H],yrange=[B,T],xstyle=1,ystyle=1
endif  ELSE  begin
          plot,v,tau(2,*),xtitle='velocity',ytitle='log N',psym=tsym,/YNOZ
endelse
if HC then !y.margin(0) = 4
if HC then plots,[0.15,0.20],[yht,yht],psym=tsym,/NORMAL
if HC then xyouts,0.25,yht-0.01,l_choice(lnum(k)),/NORMAL
!y.margin(0) = ymsav
     endif
     if (k ne 0) AND (cplt(k) lt 2) then begin
        oplot,v,tau(2,*),psym=tsym
if HC then !y.margin(0) = 4
if HC then plots,[0.15,0.20],[yht,yht],psym=tsym,/NORMAL
if HC then xyouts,0.25,yht-0.01,l_choice(lnum(k)),/NORMAL
!y.margin(0) = ymsav
     endif
     if (k eq 0) AND (cplt(k) eq 2) then begin
if (H ne 0) OR (B ne 0) OR (L ne 0) OR (T ne 0) then begin
          plot,v,tau(2,*),xtitle='velocity',ytitle='log N',/YNOZ, $
```

```
   ge=[L,H],yrange=[B,T],xstyle=1,ystyle=1
endif  ELSE  begin
          plot,v,tau(2,*),xtitle='velocity',ytitle='log N',/YNOZ
endelse
if HC then !y.margin(0) = 4
if HC then plots,[0.15,0.20],[yht,yht],/NORMAL
if HC then xyouts,0.25,yht-0.01,l_choice(lnum(k)),/NORMAL
!y.margin(0) = ymsav
     endif
     if (k ne 0) AND (cplt(k) eq 2) then begin
        oplot,v,tau(2,*)
if HC then !y.margin(0) = 4
if HC then plots,[0.15,0.20],[yht,yht],psym=tsym,/NORMAL
if HC then xyouts,0.25,yht-0.01,l_choice(lnum(k)),/NORMAL
!y.margin(0) = ymsav
     endif
     if cplt(k) eq 1 then begin
oplot,v,tau(2,*)                              ; Connect the points opt.
if HC then !y.margin(0) = 4
if HC then plots,[0.15,0.20],[yht,yht],/NORMAL
if HC then xyouts,0.25,yht-0.01,l_choice(lnum(k)),/NORMAL
!y.margin(0) = ymsav
     endif
     if pleb(k) then oplot,v,tau(1,*),psym=tsym, symsize=0.6
     if pleb(k) then oplot,v,tau(3,*),psym=tsym, symsize=0.6

     usersym,aax,aay                                  ; Over plot any Lower Limits
     if tcnt gt 1 then oplot,v(ttmp),tau(2,ttmp),psym=8
     if tcnt eq 1 then oplot,[v(ttmp),v(ttmp)],[tau(2,ttmp),tau(2,ttmp)],psym=8
     if pleb(k) then begin
        if mcnt gt 1 then oplot,v(mtmp),tau(3,mtmp),psym=8
        if mcnt eq 1 then oplot,[v(mtmp),v(mtmp)],[tau(3,mtmp),tau(3,mtmp)], $
psym=8
     endif

  endfor

  if HC then begin                                ; If in HardCopy Mode:
     spe = 'Input File: '+STAR+'.TAU'             ; Put File Name on header.
     xyouts,0.15,0.99,spe,/NORMAL
     spe = n_opt(1)
     xyouts,0.50,0.99,n_opt(snum(k)+1),/NORMAL    ; Species Name on header.
     xyouts,0.80,0.99,date,/NORMAL                ; Put Date on header.
     plotconfig,-1,spei,'',-1,kdev,'large'        ;   send to plotter & config
     HC = 0                                       ;   no longer HardCopy.
  endif

  if MKA eq 1 then begin                          ; If Making ASCII file:
     close,1                                      ;    close the file.
     MKA = 0                                      ;    no longer Making ASCII.
  endif
```

```
; -------- Master Branching Section inside LOOP --------------------

BRNCH: ;
   wtd = wmenu(c_opts,title=0,init=2)                ; call COG Menu.
   if wtd eq 4 then stop                             ; Stop - Temporary Halt.
   if wtd eq 4 then goto, BRNCH                      ;      - Start again.
   if wtd eq 7 then begin                            ; Toggle plot error bars.
      vtmp = ebtst
      if vtmp eq 0 then ebtst = 1                    ; Plots to have errors.
      if vtmp eq 1 then ebtst = 0                    ; Stop plotting errors.
      if ebtst eq 1 then c_opts(7) = 'Toggle Error Bars OFF'
      if ebtst eq 0 then c_opts(7) = 'Toggle Error Bars ON'
      if ebtst eq 1 then pleb(INUM) = 1  ELSE  pleb(INUM) = 0
      goto, PLT                                      ; Replot & Bring up Menu.
   endif
   if wtd eq 8 then begin                            ; Diff. Connect-Dots Status?
      tcnct = wmenu(ctd_opt,title=0,init=1)          ; Get choice.
      if (tcnct le 0) OR (tcnct gt 3) then goto, PLT ; Silly choice - ignore.
      if (cnct eq 2) AND (tcnct lt 3) then $         ; From line to with "dots"?
     symnum(INUM) = wmenu(s_opt,title=0,init=1)  ; Symbol choice?
      cnct = tcnct-1                                 ; Set current status & keep
      cplt(INUM) = cnct                              ;     record for the future.
      if cnct eq 2 then ebtst = 0                    ; Line only => No errors.
      if ebtst eq 0 then c_opts(7) = 'Toggle Error Bars ON'
      if ebtst eq 1 then pleb(INUM) = 1  ELSE  pleb(INUM) = 0
      goto, PLT                                      ; Replot & Bring up Menu.
   endif
   if wtd eq 9 then begin
      print,string(7B),''                            ; Ring the BELL.
      print,'Move cursor to this work area'
      read,'and enter velocity offset (km/s):',vshft
      vs(INUM) = vshft                               ; Save for later plots.
      goto, PLT                                      ; Go start again.
   endif
   if wtd eq 10 then begin                           ; Adjust f value?
      print,string(7B),''                            ; Ring the BELL.
      print,'Move cursor to this work area.'
      print,'The current value is:',lwfs(kcnt)
      read,'Enter new value of log (f-lambda)',lwftmp
      lwfs(kcnt) = lwftmp                            ; Save for later plots.
      goto, PLT
   endif
   if wtd eq 11 then begin
      userprog5,STAR,niaf,rwav,lwfs,bgs,bge,tau,kcnt ; Call user's program
      goto, BRNCH                                    ;      - Start again.
   endif
   if wtd le 0 then goto, BRNCH
   if (wtd lt 1) OR (wtd ge 12) then goto,EXIT       ; Exit Options.
   if (wtd eq 1) then begin                          ; Get NEW 1st data set.
      vshft = 0.                                     ; Velocity shift default.
      goto, START
   endif
```

```
      (wtd eq 2) then begin                          ; Add more sets of data.
        INUM = INUM + 1                              ; Incr. Image Number.
        if INUM gt 18 then begin                     ; Too many profiles!
 print,string(7B)                                ; Ring warning BELL.
 print,'WARNING: Program can only handle 19 profiles.'
 INUM = 18                                       ; Set to back to max.
        endif
        vshft = 0.                                   ; Velocity shift default.
        snum(INUM)   = which
        iaf = iafb4(which)
        goto, LOOP                                   ; Go get new set of obs.
     endif
     if wtd eq 3 then begin                          ; Want HardCopy?
        HC = 1
        goto, PLT
     endif
     if wtd eq 5 then begin                          ; Adjust plot limits?
        READ,'What are Xmin,Xmax,Ymin,Ymax?',L,H,B,T
        goto, LOOP
     endif
     if wtd eq 6 then begin                          ; Make ASCII File of data?
ASC:  afile = ''
        print,string(7B),''                          ;      Ring the BELL.
        print,'Move cursor into this Workspace and'  ;      Give directions.
        read,'Enter OUTPUT file name: ',afile        ;      Get File Name.
        close,1
        openr,1,afile, ERROR = errtst                ;      Is there one already?
        close,1
        if errtst eq 0 then begin                    ;      If file exists....
 print,string(7B),'Warning there is a file with that name.'
 yno = ''
 read,'Would you like to choose another name?  (no => destroy old)',yno
 if (yno eq 'Y') OR (yno eq 'y') then goto, ASC
        endif
        openw,1,afile                                ;      Open the file.
        MKA = 1                                      ;      Set flag to print.
        goto, PLT                                    ;      GO cycle through data
     endif
     if (wtd eq 5) OR (wtd eq 6) then goto,LOOP

;  ----------------- END Branching Section --------------------


EXIT: close,5                                        ; Close file and return.
;  !x.margin(0) = 10.                                ; Left plot margin->default.
     wdelete,0                                       ; Delete Existing window.

RETURN
END
;
;
;
```

```
;  ***************************************************************************
;    GETRDY is a setup Program for MANTAU     by Charles L. Joseph 6/1/90
;
;          STAR      file name of the .TAU file.
;          niaf      an array holding the list of species codes.
;          rwav      an array holding the list of rest wavelengths.
;          lwfs      an array holding the log f-lambdas.
;          bgs       an array holding the background levels.
;          bge       an array holding the BG errors.
;          n_opt     string array holding the different species.
;          c_opts    string array holding the program Control options.
;          s_opt     string array holding the Symbol options.
;          ctd_opt   string array holding the Connect-The-Dots? options.
;          iafb4     an array holding the distinctly unique species codes.
;                       differs from niaf in that niaf may have multiple
;                       entries of the same species.
;          knone     is the comparison value of the choice indicating none.
;
;  ***************************************************************************

pro getrdy,STAR,niaf,rwav,lwfs,bgs,bge,n_opt,c_opts,s_opt,ctd_opt,iafb4,knone

   as  = assoc(5,fltarr(200))                          ; Association variables for
   close,5
   openr,5,STAR+'.TAU'                                 ; Open file for Update & get
   niaf  = as(0)                                       ; 1st record - species codes
   rwav  = as(1)                                       ; Get addresses in .DTL file
   bgs   = as(2)                                       ; Get previous BG levels.
   bge   = as(3)                                       ; Get previous BG errors.
   dates = as(4)                                       ; Get previous date codes.
   lwfs  = as(5)                                       ; Get prev. log f-lambdas.
   close,5

   els = 'H HeLiBeB C N O F NeNaMgAlSiP S ClArK CaScTiV CrMnFeCoNiCuZn'
   els = els+'H2H2HDHDCOCHCNC2OHU U U'                 ; Elements + Molecules
   sfs = '*********   X'
   sii = 'I   II  III IV  V   VI  VII VIIIIX  X   .....'

   plotconfig,0,'Optical Depths',' ',0,kdev,''         ; Set up for type 0 window.
   i_opt = string(bytarr(26,99))                       ; Can handle 99 species.
   iafs   = where(niaf ne 0.)
   sz = size(iafs)
   if (sz(0) eq 0) then ntl = 0  ELSE ntl = sz(1)
   iafb4  = fltarr(99)
   kk = 1
   for k = 1, ntl do begin                                   ; Search through obs. data.
  nxt = FIX(iafs(k-1))                                 ; Get address of next value.
  iaftst = niaf(nxt)                                   ; Put in test variable and
  tst = where(iaftst eq iafb4)                         ; see if there are other
  sz = size(tst)                                       ; identical entries.
         if (sz(0) eq 0) then begin                          ; If not, add this species
    iafb4(kk) = iaftst                                 ; to the list.
```

```
      icnt = fix(2.*(niaf(nxt)/1000.-1))
      ii = niaf(nxt) - 1000.*FIX(niaf(nxt)/1000)
      fs = ii mod 10.
      ii = fix(ii/10)
      siaf = ''
      if icnt lt 60 then begin
         if ii le 0 then ii = 11
         if (fs gt 0) AND (fs le 9) then fs=strmid(sfs,0,fs) ELSE fs = ''
         siaf = strmid(sii,4*(ii-1),4)+fs
      endif
      if icnt ge 60 then begin
         siaf = 'vib:'+string(format='(i2)',ii)
         siaf = siaf+'   rot:'+string(format='(i2)',fs)
      endif
      i_opt(kk) = strmid(els,icnt,2)+' '+siaf
            kk        = kk + 1                        ; Incr. # of valid entries.
         endif
      endfor
      i_opt(0)  = 'Species Options'
      i_opt(kk) = 'No more'
      knone     = kk
      n_opt = i_opt(0:kk)                           ; Take only sub-array.
      iafb4 = iafb4(0:kk)

;
;  ---------------- Load the Control Menu Options ----------------------
;
      c_opts    = string(bytarr(26,13))
      c_opts(0) = 'Options:'
      c_opts(1) = 'Get New Species'
      c_opts(2) = 'Add Another Profile'
      c_opts(3) = 'Send Plot to Laser Printer'
      c_opts(4) = 'Stop - Temporary Halt'
      c_opts(5) = 'Adjust Plotting Limits'
      c_opts(6) = 'Make ASCII file of Data'
      c_opts(7) = 'Toggle Error Bars ON'
      c_opts(8) = 'Change PLOT Format'
      c_opts(9) = 'Shift Rest Wavelength'
      c_opts(10) = 'Change log (f-lambda)'
      c_opts(11) = 'Run User Program 5'
      c_opts(12) = 'Quit and Return'
;
;  ---------------- Load Plotting Symbol Options -----------------------
;
      s_opt    = string(bytarr(16,10))
      s_opt(0) = 'Plotting Symbols'
      s_opt(1) = 'Plus sign'
      s_opt(2) = 'Asterisk'
      s_opt(3) = 'Filled Circle'
      s_opt(4) = 'Diamond'
      s_opt(5) = 'Triangle'
      s_opt(6) = 'Square'
```

```
   s_opt(7) = 'X'
   s_opt(8) = 'Open Circle'
   s_opt(9) = 'Line - no pts'

;  ------------- Load Connect the Dots Options ----------------------

   ctd_opt  = string(bytarr(24,4))
   ctd_opt(0) = 'Connect the DATA points?'
   ctd_opt(1) = 'Plot only as DOTS'
   ctd_opt(2) = 'Plot as DOTS and CONNECT'
   ctd_opt(3) = 'Plot data only as a LINE'

RETURN
END

PRO INTGRT,Y,X,CNT,TAU,JE,XF,XI,XLIMIT,mdata,mp,mcntrl,up
;
;********************************** INTGRT ************************************
;
;      By Charles L. Joseph                    Jan. 12, 1984   June, 1990
;
;        DETERMINES EQUIVALENT WIDTHS OR INTEGRATED FLUXES
;             OF ABSORPTION OR EMISSION FEATURES
;
;      A TRAPOZOIDAL METHOD IS USED TO COMPUTE THE INTEGRATION
;
;           Y        flux vector
;           X        wavelength vector
;           CNT      continuum vector
;           EPS      epsilon vector (data quality)
;           JE       index of cursor
;           XF       final wavelength value allowed for in fits or integration
;           XI       initial or first wavelength value ( XI=left, XF=right)
;           mp       structure containing mp.wtd   -1 => exit
;
;
;*****************************************************************************
;
    HC = 0                                          ; HardCopy Flag -> NO.
    xxxs = fltarr(2)                                ; For Overplot markers.
    yyys = fltarr(2)                                ; For Overplot markers.
    sz = size(JE)                                   ; Determine # of profiles
    if sz(0) eq 0 then lcs = 1 else lcs = sz(1)     ; to be measured.
    xmx = max(XLIMIT,J3)                            ; Get longest wavelength.
    xmx = max(x,J2)                                 ;
    jmx = fix(J2/2)                                 ; Temporary use of jmx.
    mp.SNR  = (CNT(jmx)-mp.bg)/mcntrl.ESAV          ; Signal-to-Noise Ratio.
    jmx = J2
    xmn = min(x)
    while (X(J2) gt xmx) do J2=J2-1                 ; Find & adjust XLIMIT's
    XLIMIT(J3) = X(J2-3)                            ; Exclude last 3 points.
    kcnt = 0                                        ; # of pts in integration
```

```
sz = size(X)
jcnt = 1
if sz(1) gt 16 then jcnt = fix(sz(1)/16)          ; Size for BG overplot.


IF mcntrl.intopt EQ 0 THEN BEGIN  ; <<<<<<<<<<<<<<<< ; Use nonstndrd ALT_INT?

;  ............... The following 6 print statements may NOT be removed legally.

   print,' ',string(7B)
   print,string(7B),'No Alternate Integration Routine is Provided'
   print,'in standard M.S.L.A.P. - version 1.0'
   print,' '
   print,'Origin of the Alt. Integration Routine is as follows:'
   print,' '

   ALT_INT,X,Y,CNT,TAU,JE,XF,XI,kcnt,XLIMIT,mdata,mp,mcntrl
   auto_int_sav,X,Y,CNT,mp,mcntrl,up,XLIMIT,XI,XF   ; Default call: A dummy.

END ELSE BEGIN  ; <<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<< ; Use Standard EQUIVW.

kkcnt = 0
for k=0,lcs-1 do begin
        sdata = mdata(k)                              ; Get next mult. ID.
   print,string(sdata.el)                       ; Print species name.
        if lcs gt 1 then xxf=XF(k)  else xxf=XF      ; Get next stopping point
        if lcs gt 1 then xxi=XI(k)  else xxi=XI      ; Get next starting point
        if lcs gt 1 then jje=JE(k)  else jje=JE      ; Get next line center.
;       mp.SNR = 1./(mcntrl.ESAV/CNT(jje))
        mp.SNR  = (CNT(jje)-mp.bg)/mcntrl.ESAV       ; Calc. S/N from Contim.
        EQUIVW,X,Y,CNT,TAU,jje,xxf,xxi,kcnt,XLIMIT,sdata,mp,mcntrl,up
        auto_int_sav,X,Y,CNT,mp,mcntrl,up,XLIMIT,xxi,xxf ; Default: A dummy.
    if (kkcnt+kcnt gt 0) then tautmp = fltarr(6,kkcnt+kcnt)
    if k eq 0 then begin
      if kcnt gt 0 then tautmp = TAU           ; Save Tau's, if any.
        END ELSE  BEGIN
      if kkcnt gt 0 then tautmp(0:5,0:kkcnt-1) = tausv
      if kkcnt gt 0 then tautmp(0:5,kkcnt:kkcnt+kcnt-1) = TAU
        endelse
    kkcnt = kkcnt + kcnt
    if kkcnt gt 0 then tausv = tautmp            ; Save any Tau's.
    sdata.up  = up                               ; Fold UserPar into data
        mdata(k) = sdata                              ; Put into mult. data.
     endfor
     kcnt = kkcnt                                     ; Tidy up counter and
if kcnt gt 0 then TAU = tautmp                   ; optical depths array.

ENDELSE  ; <<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<  ; End Standard EQUIVW.


; ------------------- Plot Results Section ----------------------------------
```

```
PLTSTRT: if !d.name eq 'PS' then device,/CLOSE                    ;
  tle = '.............. Measurement Results'                      ; Title for window.
  plotconfig,HC,'',tle,2,kdev,''                                  ; Configure graphics.
; if HC eq 1 then device,/ENCAPSULATED,FILENAME='intgrt2.ps'
 ; TAUs => profile areas:
    ymn = min(tau(4,0:kcnt-1),J5)                                 ; Find min and max flux
    ymx = max(Y)                                                  ;   to see if plot BG.
    if (ymn lt 0.2*ymx) then pbg = 1 ELSE pbg = 0                 ; Set plot BG flag.
  if pbg then begin                                               ; Going to show BG+error
     vmn = mp.bg - mp.bgerr                                       ; Get min. needed for BG
     if vmn lt 0 then vmn = 1.1*vmn                               ; Adjust for more space.
     if ymn lt vmn then vmn = ymn                                 ; Less than min. spect?
     ymx = 1.1*ymx                                                ; Adjust for more space.
     xxxs(0) = xmn   &   xxxs(1) = xmx                            ; Put limits into small
     yyys(0) = vmn   &   yyys(1) = ymx                            ;   over plot array &
                                                                  ;   let IDL make axis.
     plot,xxxs,yyys,/NODATA, xtitle='Wavelength (A)', ytitle='Rel. Flux'
     if mp.SMO then oplot,X,SMOOTH(Y,9) else oplot,X,Y            ; Now really plot data.
     vmn = where(x lt tau(0,J5),jbg)                              ; Get ready to overplot
     if (jbg gt jcnt) then xxxs(0) = x(jbg-jcnt) ELSE xxxs(0)=x(0)  ;   BG range.
     if (jbg lt jmx-jcnt) then xxxs(1)=x(jbg+jcnt) ELSE xxxs(0)=x(jmx)
     yyys(0:1) = mp.bg
     oplot,xxxs,yyys                                              ; Over plot BG.
     yyys(0:1) = mp.bg - mp.bgerr
     oplot,xxxs,yyys,linestyle=2                                  ; Over plot BG-BGerror.
     yyys(0:1) = mp.bg + mp.bgerr
     oplot,xxxs,yyys,linestyle=2                                  ; Over plot BG+BGerror.
  endif
  if pbg ne 1 then begin                                          ; NOT going to show BG.
     if mp.SMO then plot,X,SMOOTH(Y,9),/YNOZ, xtitle='Wavelength (A)', $
     ytitle='Flux' else plot,X,Y,/YNOZ,xtitle='Wavelength (A)',ytitle='Rel. Flux'
  endif
  if mp.SMO ne 1 then oplot,X,Y,psym=8
  oplot,X,CNT                                                     ; Put on continuum.
  plotlab2,X,Y,CNT,mp,mcntrl,up                                   ; Customized labels.
  xxo=0.0*(!x.crange(1)-!x.crange(0)) + !x.crange(0)
  yyo=1.05*(!y.crange(1)-!y.crange(0)) + !y.crange(0)
  xyouts,xxo,yyo,mp.FNAM                                          ; Put on File name.
  xxo=0.65*(!x.crange(1)-!x.crange(0)) + !x.crange(0)
  xyouts,xxo,yyo,systime(0)
  if kcnt gt 0 then begin                                         ; Show areas that were
     for kk=0,kcnt-1 do begin                                     ; integrated.
         xxxs(0:1) = tau(0,kk)
         yyys(0) = tau(4,kk)
         yyys(1) = tau(5,kk)
  oplot,xxxs,yyys
     endfor
  endif
  xdum = where(XLIMIT gt 0,nxs)
  yout = 0.07*(!y.crange(1)-!y.crange(0)) + !y.crange(0)
  for kk=0,nxs-1,2 do begin                                       ; Show the areas that
```

```
    yyys(0) = !y.crange(0)                                  ; Set to plot top to
    yyys(1) = !y.crange(1)                                  ;    bottom.
    xxxs(0:1) = XLIMIT(kk)                                  ; were used to calculate
    oplot,xxxs,yyys,linestyle=1                             ; polynomail fit of the
    xxxs(0:1) = XLIMIT(kk+1)                                ; continuum.
    oplot,xxxs,yyys,linestyle=1
    xxxs(0) = XLIMIT(kk)
    yyys(0:1) = yout                                        ; Connect solid line for
    oplot,xxxs,yyys                                         ; continuum areas.
endfor

!y.margin(0) = 1                                            ; Enable text area.

spe = 'Measurements in file: '+mp.STAR+'.DTL'               ; Create string.
xyouts,0.05,0.32,spe,/NORMAL                                ; Print File name.
spe = 'Real S/N = '+string(format='(f6.1)',mp.SNR/(mp.cohfac^0.5))
xyouts,0.765,0.32,spe,/NORMAL
spe = string(format='(f6.1)',mp.SNR)                        ; Start building string.
spe = 'Apparent S/N Ratio:'+spe+' based on '
spe = spe+string(format='(i3)',mcntrl.NNE)+' points with a Noise '
spe = spe+'Coherence Length of'+string(format='(f4.1)',mp.cohfac)
xyouts,0.05,0.30,spe,/NORMAL                                ; Print S/N results.
spe = string(format='(i2)',mp.poly)                         ; Start building string.
spe = 'Continuum was fit with a polynomial of order:'+spe+'                    '
spe = spe+string(format='(f9.2)',mcntrl.f1n)+string(format='(f9.2)',mcntrl.f2n)
xyouts,0.05,0.28,spe,/NORMAL                                ;
spe = 'BG (background) was taken to be:'                    ; Start building string.
spe = spe+string(format='(f12.1)',mp.bg)+'   +/-'
spe = spe+string(format='(f12.1)',mp.bgerr)
xyouts,0.05,0.26,spe,/NORMAL                                ; Print BG & uncertainty
sdata = mdata(0)
spe = 'For '+string(sdata.el)
xyouts,0.05,0.24,spe,/NORMAL                                ; BG Error contribs.
spe = string(format='(f8.3)',sdata.wl)
xyouts,0.24,0.24,spe,/NORMAL
spe = ' error contributions from BG:'                       ; Start building
spe = spe+string(format='(f9.4)',mcntrl.e0)                 ;      a string.
spe = spe+string(format='(f9.3)',mcntrl.e1)+string(format='(f9.3)',mcntrl.e2)
xyouts,0.34,0.24,spe,/NORMAL                                ; BG Error contribs.
spe = 'Errors below are the Addition in Quadrature of'      ; Build string for a
spe = spe+' the Background and RMS-Noise Errors'            ;    note on errors.
xyouts,0.05,0.22,spe,/NORMAL                                ; BG Error contribs.
spe = 'Species'
xyouts,0.05,0.18,spe,/NORMAL
spe = 'Lab. Wave.'
xyouts,0.21,0.18,spe,/NORMAL
spe = 'f'
xyouts,0.35,0.18,spe,/NORMAL
spe = 'Obs. Wave'
xyouts,0.43,0.18,spe,/NORMAL
spe = ' EQW (A)  1st (km/s)   2nd (km/s/s)'
xyouts,0.57,0.18,spe,/NORMAL
```

```
    for k=0,lcs-1 do begin                                    ; For each measurement:
      sdata = mdata(k)                                        ;   - Get Measurements.
      yht = 0.16 - 0.04*k                                     ;   - Adj. print locat.
      spe = string(sdata.el)
      spe = strtrim(spe,2)+'.............'
      spe = strmid(spe,0,15)
      xyouts,0.05,yht,spe,/NORMAL                             ;   - Print moments.
      spe = string(format='(f8.3)',sdata.wl)
      xyouts,0.21,yht,spe,/NORMAL                             ;   - Print moments.
      spe = string(format='(f6.4)',sdata.f)
      xyouts,0.33,yht,spe,/NORMAL
      spe = string(format='(f8.3)',sdata.owl)
      xyouts,0.43,yht,spe,/NORMAL
      spe = string(format='(f10.4)',sdata.eqw)    ;   - Build a string.
      xyouts,0.55,yht,spe,/NORMAL                             ;   - Print moments.
      spe = string(format='(f10.3)',sdata.fm)
      xyouts,0.67,yht,spe,/NORMAL                             ;   - Print moments.
      spe = string(format='(f10.3)',sdata.sm)
      xyouts,0.82,yht,spe,/NORMAL                             ;   - Print moments.
      yht = 0.14 - 0.04*k                                     ;   - Adj. print locat.
      xyouts,0.47,yht,'Errors:',/NORMAL
      spe = string(format='(f10.4)',sdata.me)         ;     values.
      xyouts,0.55,yht,spe,/NORMAL                             ;   - Print errors.
      spe = string(format='(f10.3)',sdata.fme)
      xyouts,0.67,yht,spe,/NORMAL                             ;   - Print errors.
      spe = string(format='(f10.3)',sdata.sme)
      xyouts,0.82,yht,spe,/NORMAL                             ;   - Print errors.
  endfor
  if HC eq 1 then plotconfig,-1,' ',' ',-1,kdev,''            ; Send plot & -> term.
  if HC eq 0 then begin                                       ; If not already making
     HC = wmenu(['Copy?','Yes','No'],title=0, init=1)         ; a hardcopy, want to?
     if HC eq 1 then goto, PLTSTRT                            ; If yes, go do it.
  endif
EXIT: CLOSE,4                                                 ; close it up
    wdelete,2                                                 ; Delete extra window.
    RETURN                                                    ; go back to DETAILS
END ; INTGRT                                                  ;
;
;
;
;
PRO EQUIVW,X,Y,C,TAU,JE,XF,XI,kcnt,XLIMIT,sdata,mp,mcntrl,up
;
;  ********************************** EQUIVW ********************************
;
;  COMPUTES INTEGRATED FLUX - ABSORPTION OR EMISSION LINES
;
;                  TRAPOZOIDAL METHOD
;
;        X         wavelength vector
;        Y         flux vector
;        C         continuum vector
```

```
;       JE      index of cursor position
;       XF      right def. and stop point
;       XI      left  def. and stop point
;       kcnt    number of points used in the integration
;       XLIMIT  cursor positions used to define continuum regions
;       sdata   structure containing the ID plus moments and errors
;       mp      structure MSLAPparameter
;       mcntrl  structure for some control variables
;       up      UserParameter, a 30 point floating vector which is
;                              reserved exclusively for the user.
;
;
;       Translated to IDL by  C. JOSEPH  7/1/89 from code by E. Jenkins
;
;*****************************************************************************

    J1 = 0
    while (X(J1) lt XI) do J1=J1+1              ; Find left edge of integrat-
    xmx = max(x,J2)                             ; ing region.
    while (X(J2) gt XF) do J2=J2-1              ; Find right edge of integr-
    kcnt = J2 - J1 + 1                          ; ating region.
    X0 = 0.0
    BKG = mp.bg
    CF2 = 9.0
    COHFAC = mp.cohfac                          ; Set Coherence Factor.
    EBKG = mp.bgerr                             ; Set background error est.
    V = fltarr(5,3)                             ; create array: V
    EM = fltarr(5)                              ; create array: EM
    ER = fltarr(5)                              ; create array: ER
    EE = EM                                     ; create array: EE
    F  = EM                                     ; create array: F
    A = fltarr(6,600)                           ; create array: A

    XSAV = X
    velfact = 2.9979e05/sdata.wl
    X = velfact*(X-sdata.wl)
    xje = X(JE)
    X = X - X(JE)

    QDELT = (X(J2) - X(J1))/FLOAT(J2 - J1)      ;
    for II = J1,J2 do begin                     ; For each integration point:
        D = (C(II) - Y(II))                     ; Calculate Continuum - Flux
        B = C(II) - BKG                         ; and Continuum - Background.
        A(0,II) = D/(B + EBKG)                  ; Use these to find the fract-
        A(1,II) = D/B                           ; ion of missing flux, taking
        A(2,II) = D/(B - EBKG)                  ; into account BG errors.
        X1 = X(II) - X0                         ; Calculate weighting for
        X2 = X1^2                               ; 1st and 2nd moments.
        for J = 0,2 do begin
            V(0,J) = V(0,J) + A(J,II)           ; Update 0th, (equiv. width)
            V(1,J) = V(1,J) + A(J,II)*X1        ;        1st, and
            V(2,J) = V(2,J) + A(J,II)*X2        ;        2nd moments for the
```

```
    endfor                                          ;       three BG cases.
endfor
for J = 1,3 do begin
    V(1,J-1) = V(1,J-1)/V(0,J-1)                    ; Normalize 1st & 2nd mom.
    V(2,J-1) = V(2,J-1)/V(0,J-1) - V(1,J-1)^2
endfor
EM(0) = FLOAT(J2 - J1 + 1)/COHFAC
for j=1,4 do EM(j) = EM(j-1)*EM(0)
for J = 0,4 do F(J) = ABS(V(J,2) - V(J,0))/2.
F(0) = F(0)*QDELT
JCENT = (J1 + J2)/2
SIOC2 = 1./(mp.SNR^2)
SCOC2 = SIOC2/FLOAT(mcntrl.NNE)
T1 = SIOC2*EM(0)
T2 = SCOC2*(EM(0) - V(0,1)/COHFAC)^2
EE(0) = COHFAC*SQRT(T1 + T2)
VB2 = ((V(1,1) - X(JCENT) + X0)/QDELT)^2
V3Q = V(2,1)/QDELT^2
EE(1) = COHFAC*SQRT(SIOC2*(EM(2)*CF2/12. + EM(0)*VB2) $
        + SCOC2*EM(1)*VB2)/V(0,1)
Q = EM(2)*CF2/12. + EM(0)*VB2
EE(2) = COHFAC*SQRT(SIOC2*(EM(4)*CF2^2/80. + EM(2)*CF2*VB2/2. $
        + EM(0)*VB2^2 - 2.*V3Q*Q                $
        + EM(0)*V3Q^2) + SCOC2*(Q - EM(0)*V3Q)^2)/V(0,1)
EE(2) = EE(2)*QDELT
for J = 0,4 do begin
    EE(J) = EE(J)*QDELT
    ER(J) = SQRT(EE(J)^2 + F(J)^2)
endfor
V(0,1) = V(0,1)*QDELT
sdata.eqw = V(0,1)/velfact                          ; Save Equivalent Width (A).
sdata.me  = ER(0)/velfact                           ; Save its error.
sdata.owl = (V(1,1)+xje)/velfact + sdata.wl         ; Save observed wavelength.
sdata.fm  = V(1,1)+xje                              ; Save first momement.
sdata.fme = ER(1)                                   ; Save its error.
sdata.sm  = V(2,1)                                  ; Save 2nd momement.
sdata.sme = ER(2)                                   ; Save its error.
mcntrl.e0 = F(0)/velfact                            ; BG contrib. to EQW error.
mcntrl.e1 = F(1)                                    ; BG contrib. to 1st error.
mcntrl.e2 = F(2)                                    ; BG contrib. to 2nd error.

;  ------------------- Calculate the Optical Depths ---------------------

    X = X + X(JE)                                   ; Change origin of vel. back.
    SCOC = SQRT(SCOC2)
    B = C(J1:J2) - BKG
    D = C(J1:J2) - Y(J1:J2)
    A(2,0:J2-J1) = D / B                            ; TAU's for no BG error.
    CCOR = C*SCOC
    D = D - CCOR
    B = B - CCOR
    A(1,0:J2-J1) = D / (B + EBKG)                   ; Minimum TAU's.
```

```
      D = D + 2.*CCOR
      B = B + 2.*CCOR
      A(3,0:J2-J1) = D/(B - EBKG)                    ; Maximum TAU's.
      A = 1.0 - A(*,0:J2-J1)
      A = -1.0*ALOG(A > 4.e-5)                       ; Limit the range.
      A = ALOG10(A > 0.005)
      X = XSAV                                       ; Return X to wavelength.
      A(0,0:J2-J1) = X(J1:J2)                        ; Wavelengths for TAU's.
      A(4,0:J2-J1) = Y(J1:J2)                        ; Store Spectrum.
      A(5,0:J2-J1) = C(J1:J2)                        ; Store Fit Continuum.
      TAU = A                                        ; All info. -> TAU array.
RETURN                                               ; back to INTGRT
END ; EQUIVW                                         ;
;

; ------------------------------------------------------------------------
;  This routine sets plotting configuration throughout M.S.L.A.P.   It sizes
;  the plot windows, correctly adjusting for the environment.  It also directs
;  the plots to various terminals or hard copy devices.
;
;        HC       HardCopy flag  -1 Close Hardcopy device & set to terminal.
;                                 0 Terminal or console.
;                                 1 HardCopy Unit - currently PostScript.
;        tl0      Title for window 0.
;        tl2      Title for window 2.
;        wtype    open new window of various types.
;                    -2 => No New window  - reset to default plot parameters.
;                                         - ALSO: Do not produce CURSORS.
;                    -1 => No New window  - reset to default plot parameters.
;                     0 => window 0   ----- the large, main plotting window.
;                     1 => windows 0 & 1  - MAIN plus ONE for the cursor coords.
;                     2 => window 2   ----- the expanded results window.
;                     3 => window 3   ----- small instructions window, then do
;                                           an immediate return.
;        kdev     Terminal Device Type  either a 'sun' or 'xterm' is returned.
;        xmarg    Sets !x.margin(0), the left edge of the plot.
;                    xmarg = 'large'  => more space to WMENU functions.
;                    Note: xmarg = 'large' overrides the wtype variable.
;
; ------------------------------------------------------------------------
pro plotconfig,HC,tl0,tl2,wtype,kdev,xmarg

if wtype eq 3 then begin                             ; Only open window 3
   window,3,title='',xpos=450,ypos=830,xsize=450,ysize=40  ; for intructions.
   return                                            ; RETURN.
endif

kdev = getenv('TERM')                                ; Get terminal type.
if kdev ne 'sun' then kdev='xterm'                   ; Assume X window or SUN

if HC lt 0 then begin                                ; Finish HC plotting.
   device,/CLOSE                                     ; Close device/PS-file.
```

```
   spawn,'mv -f idl.ps temp.ps'                          ; Move the plot file.
   spawn,'lpr temp.ps'                                   ; Send to laser printer
   HC = 0                                                ; Flag to terminal.
endif

; ---------------------------------------------------------------------

if (HC eq 0) AND (kdev eq 'xterm') then begin            ; If screen & X window.
   set_plot,'X'
   if wtype eq 0 then begin                              ; Only MAIN window.
      window,0,color=2,xpos=200,ypos=350,xsize=820,ysize=550,title=t10
   endif
   if wtype eq 1 then begin                              ; Two windows wanted.
      window,0,color=2,xpos=200,ypos=350,xsize=820,ysize=550,title=t10
      window,1,xpos=770,ypos=150,xsize=200,ysize=50,title='Cursor Coordinates'
      wset,0                                             ; Ready for window 0.
   endif
   if wtype eq 2 then begin                              ; Expanded results wind.
      window,2,color=2,xpos=250,ypos=50,xsize=770,ysize=820,title=t12
      !y.margin(0) = 30                                  ; Reserve text area.
   endif
   if wtype lt 0 then !y.margin(0) = 4                   ; Default under graph.
   if wtype lt 0 then !x.margin(0) = 10.                 ; Default left margin.
endif

if (HC eq 0) AND (kdev eq 'sun')   then begin            ; If screen & Sunview.
   set_plot,'SUN'
   if wtype eq 0 then begin                              ; Only MAIN window.
      window,0,color=2,title=t10,xpos=100,ypos=270,xsize=1030,ysize=600
   endif
   if wtype eq 1 then begin                              ; Two windows wanted.
      window,0,color=2,title=t10,xpos=100,ypos=270,xsize=1030,ysize=600
      window,1,title='Cursor Coordinates',xpos=820,ypos=180,xsize=200,ysize=50
      wset,0                                             ; Ready for window 0.
   endif
   if wtype eq 2 then begin                              ; Expanded results wind.
      window,2,color=2,title=t12,xpos=250,ypos=50,xsize=880,ysize=820
      !y.margin(0) = 21                                  ; Reserve text area.
   endif
   if wtype lt 0 then !y.margin(0) = 4                   ; Default under graph.
   if wtype lt 0 then !x.margin(0) = 10.                 ; Default left margin.
endif

; ---------------------------------------------------------------------

if xmarg eq 'large' then begin                           ; Extra room for WMENU.
   !x.margin(0) = 30.                                    ;    for Sunview window.
   if kdev eq 'xterm' then !x.margin(0) = 50.            ;    X window on SUN.
endif

if HC eq 1 then begin                                    ; If HardCopy Unit.
   set_plot,'PS'
```

```
   ...ICE,/INCHES,YOFFSET=2.8,YSIZE=7.5                    ; Adjust plot area.
   !y.margin(0) = 24.                                      ; Reserve text area.
   !x.margin(0) = 10.                                      ; Use all hor. space.
endif

if wtype eq -2 then return                                 ; Avoid making cursors.

if HC eq 0 then device,/CURSOR_CROSSHAIR                   ; Graphical cursors &
if HC eq 0 then TVCRS,0.5,0.5,/NORMAL                      ; place on screen.

RETURN
END ; plotconfig

;*****************************   COG.PRO  ************************************
;
;            CURVE OF GROWTH   -  for workstations
;                              -  Input input files are from MSLAP
;
;                  By Charles L. Joseph:          5/22/79
;                  Latest Modification:          10/19/90
;
;
;*******************************************************************************
PRO COG,STAR,date,libr
nulld = { noda, el: bytarr(15), iaf: long(0), wl: 0., f: 0., vel: 0., eqw: 0., $
   me: 0., fm: 0., fme: 0., sm: 0., sme: 0., com: bytarr(10), up: fltarr(30) }
   dtl = replicate({ noda }, 200)                          ; Make array for storage
   kdev = getenv('TERM')
        FIREUP,IAF,DV,STAR,dtl,n_opt,c_opts,s_opt,nns,iafb4,cch,knone
        wtd = wmenu(c_opts,title=0,init=1)                 ; Input What-To-Do Flag
if wtd eq 4 then stop                                      ; Stop - Temporary Halt.
if (wtd lt 1) OR (wtd ge 7) then goto,EXIT                 ; Exit Options.
if wtd gt 2 then wtd = 2                                   ; Temp. void options.
        symnum = intarr(9)                                 ; Zero plot symbol table
snum   = intarr(9)                                         ; Zero species table.
cdsav  = fltarr(9)                                         ; Column Density mstr tab
melsv  = fltarr(9,2,20)                                    ; Mean Error mstr table.
cogi   = string(80)
STRT:   ; ------------ Starting place for 1st species ----------------------
        INUM = 0                                           ; Initialize Image Number
eqlsv  = fltarr(9,20)                                      ; log(EQW) master table.
wfsav  = fltarr(9,20)                                      ; log(Wf) master table.
if (wtd eq 1) OR (wtd eq 2) then begin                     ; Start with 1st data.
           which = wmenu(n_opt,title=0,init=1)             ; Get species choice.
   if which eq knone then goto, EXIT                       ; Choice: "No More".
   snum(INUM)   = which                                    ; Save Species Number
   iaf = iafb4(which)
   tst = where(cch eq iaf)                                 ; Computer's Choice for
           sz = size(tst)                                  ; the theo. CogNumber
           if (sz(0) eq 0) then cnum=3 else cnum=tst(0)
   openr,1,libr+'/coginfo.tab'
   for k=0,cnum do readf,1,cogi
```

```
   close,1
   cwf = float(strmid(cogi,71,7))
   print,cwf
   plotconfig,0,cogi,' ',0,kdev,'large'          ; Open type 0 window.
;          !x.margin(0) = 30.                    ; Make plot more square.
;          if kdev eq 'xterm' then !x.margin(0)=50.   ; X window a little diff.
           symnum(INUM) = wmenu(s_opt,title=0,init=1)   ; Get symbol choice.
endif
whichcogs,nns,NS,NT                              ; Which C.O.G.'s to use?
T = 0. & B = 0.  & L = 12.                       ; Set plot for autoscale.
START:  ; ---------- Starting place for Additional Species --------------------
        iaf = long(0)                                    ; iaf code id's species.
print,iafb4(which),long(iafb4(which))
        if (which gt 0) then iaf = long(iafb4(which))
        GRAB,STAR,C,IAF,WF,EQL,MEL,WAF,F,W,EQW,NL,ML,ME,L,dtl,cnum
wfsav(INUM,0:NL-1) = WF                          ; Update master log(Wf).
eqlsv(INUM,0:NL-1) = EQL                         ; Update master log(EQW).
melsv(INUM,0:1,0:NL-1) = MEL
        IF NL LT 0 THEN GOTO, EXIT

LOOP:   ; -------- Master LOOP to shift Obs. relative to theo. C.O.G. -------

        LINES,A,NT,NS,M,H,L,T,B,WO,EQL,libr,which       ; DRAWS C.O.G.
plotem,wfsav,eqlsv,symnum,melsv,n_opt,snum,INUM ; Overplot Obs. data.
PRINT,' '
print,'Use left mouse to locate a starting data position for translation'
print,'Use right mouse to bring up a MENU of options.'
        CURSOR,X1,IY
if kdev eq 'xterm' then wait,1                   ; X window?  Slow down.

; -------- Master Branching Section inside LOOP ---------------------

if !ERR eq 4 then begin                          ; If right mouse, then
   wtd = wmenu(c_opts,title=0,init=2)            ; call COG Menu.
   if wtd eq 4 then stop                         ; Stop - Temporary Halt.
   if wtd le 0 then goto, LOOP
   if (wtd lt 1) OR (wtd ge 7) then goto,EXIT    ; Exit Options.
   if (wtd eq 1) then begin                      ; Get NEW 1st data set.
      tst = 1                                    ; OK, if not much data.
      if INUM gt 1 then begin                    ; Check before data loss.
 print,string(7B)
 print,'Warning: Previous Column densities will be erased'
 tst = wmenu(['Confirm','Yes','No'],title=0,init=2)
      endif
      if tst eq 1 then goto,STRT                 ; Confirmed, start over.
      goto, LOOP                                 ; Continue on.
   endif
   if (wtd eq 2) then begin                      ; Add more sets of data.
            which = wmenu(n_opt,title=0,init=1)       ; Get species choice.
      if which eq knone then goto, LOOP          ; Choice: "No More".
      INUM = INUM + 1                            ; Incr. Image Number.
      snum(INUM)   = which
```

```
            symnum(INUM) = wmenu(s_opt,title=0,init=1) ; Get symbol choice.
      goto, START                                      ; Go get new set of obs.
    endif
    if wtd eq 3 then goto, HC                          ; Go make hardcopy?
          if wtd eq 5 then $                                  ; Adjust plot limits?
            READ,'What are Xmin,Xmax,Ymin,Ymax?',L,H,B,T
    if wtd eq 6 then whichcogs,nns,NS,NT               ; Change # of curves?
    if (wtd eq 5) OR (wtd eq 6) then goto,LOOP
        endif  ; ---------------- END Branching Section --------------------

print,' '
print,'Use left mouse to indicate new location for the translation.'
        CURSOR,IX,IY
if kdev eq 'xterm' then wait,1                         ; X window?  Slow down.
        WF=WF+IX-X1
wfsav(INUM,0:NL-1) = WF
        LINES,A,NT,NS,M,H,L,T,B,WO,EQL,libr,which       ; DRAWS C.O.G.
plotem,wfsav,eqlsv,symnum,melsv,n_opt,snum,INUM ; Overplot Obs. data.
print,'Total SHIFT: ',wf(0)-waf(0)
cdl = wf(0) - waf(0) + cwf
cdsav(INUM) = cdl
print,'Log Column Density: ',cdl,' for current set of observations'
goto, LOOP

HC:     PRINT,' '
;       !x.margin(0) = 10.                                ; Set left margin back.
plotconfig,1,' ',' ',-1,kdev,' '                       ; Set up for hardcopy.
        LINES,A,NT,NS,M,H,L,T,B,WO,EQL,libr,which       ; DRAWS C.O.G.
if nt gt 5 then xyouts,0.7,0.66,'b Values',/NORMAL $ ; Position & write
else xyouts,0.7,0.6,'b values',/NORMAL                 ; Doppler broadening vals.
for k=NS,NS+NT-1 do begin
    if nt gt 3 then yht = 0.63-0.02*(k-NS)
    if nt le 3 then yht = 0.57-0.02*(k-NS)
    xyouts,0.69,yht,DV(k)+'  km/s',/NORMAL
endfor
plotem,wfsav,eqlsv,symnum,melsv,n_opt,snum,INUM ; Overplot Obs. data.
!y.margin(0) = 4                                       ; Enable text area.
spe = 'Obs. data from file: '+STAR+'.DTL'              ; Create string.
xyouts,0.1,0.28,spe,/NORMAL                            ; Print Data file name.
xyouts,0.85,0.28,date,/NORMAL                          ; Print date of analysis.
xyouts,0.1,0.26,cogi,/NORMAL                           ; Print Theo. COG info.
for k=0,INUM do begin                                  ; For each species, write
    yht = 0.22 - 0.02*k                                ; log N, column density.
    spe = strtrim(n_opt(snum(k)))                      ; Get species name.
    spe = 'log N('+spe+')'
    xyouts,0.1,yht,spe,/NORMAL                         ; Print species.
    spe = ' = '+strtrim(string(cdsav(k)))
    xyouts,0.35,yht,spe,/NORMAL                        ; Print column density.
        endfor
        IF NL LE 7 THEN STP=NL ELSE STP=7
plotconfig,-1,' ',' ',-1,kdev,'large'                  ; Send plot & -> terminal.
;       !x.margin(0) = 30.                                    ; Make plot more square.
```

```
;       if kdev eq 'xterm' then !x.margin(0)=50.        ; X window a little diff.
        GOTO,LOOP
EXIT:   wdelete,0
;       !x.margin(0) = 10.                              ; Set back to default.
RETURN
END
;
;
;
;
PRO FIREUP,IAF,DV,STAR,dtl,n_opt,c_opts,s_opt,nns,iafb4,cch,knone
;*********************  FIREUP.PRO   ***********************************
;
;       TO DETERMINE WHICH C.O.G.  IS TO BE USED.
;       AND TO SET VARIOUS PARAMATERS.
;
;       by Charles L. Joseph                        5/19/79
;*************************************************************************
;                          ********       OPEN THE INFO FILE
;
     close,1
     openr,1,STAR+'.DTL', ERROR = errtst            ; Does file exists?
     close,1
     app = ' '
     if errtst eq 0 then begin
        CLOSE,1
        OPENU,1,STAR+'.DTL'                         ; Get old file.
        ML=200
        readu,1,dtl
        iafs = where(dtl.iaf ne 0.)                 ; Get # of lines.
        sz = size(iafs)
        if (sz(0) eq 0) then ntl = 0 else ntl = sz(1)
        close,1
     endif
     plotconfig,0,'Curve of Growth',' ',0,kdev,' '  ; Set up for type 0 window.
     i_opt = string(bytarr(26,99))                  ; Can handle 99 species.
     iafdat = dtl.iaf
     iafs   = where(iafdat ne 0)
     iafb4  = long(intarr(99))
     iondat = dtl.el
     kk = 1
     for k = 1, ntl do begin                            ; Search through obs. data.
  nxt = iafs(k-1)                                ; Get address of next value.
  iaftst = iafdat(nxt)                           ; Put in test variable and
  tst = where(iaftst eq iafb4)                   ; see if there are other
  sz = size(tst)                                 ; identical entries.
         if (sz(0) eq 0) then begin                     ; If not, add this species
    iafb4(kk) = iaftst                           ; to the list.
    i_opt(kk) = string(iondat(0:9,nxt))
           kk        = kk + 1                          ; Incr. # of valid entries.
         endif
     endfor
```

```
      i_opt(0)  = 'C.O.G. Choices'
      i_opt(kk) = 'No more'
      knone     = kk
      n_opt = i_opt(0:kk)                          ; Take only sub-array.
      iafb4 = iafb4(0:kk)
;
; ------------  Load Table of Available Theo. C.O.G. ----------------
;
   cch  = intarr(5)
   cch(0) = 26020                                  ; Fe II COG
   cch(1) = 12020                                  ; Mg II COG
   cch(2) = 25020                                  ; Mn II COG
   cch(3) =  8010                                  ; O I   COG, default
   cch(4) = 14020                                  ; Si II COG
;
; ----------------  LOAD THE DOPP VEL VALUES  ----------------------

      DV    =string(BYTARR(3,11))
      DV(1) = '1.0'
      DV(2) = '1.5'
      DV(3) = '2.0'
      DV(4) = '3.0'
      DV(5) = '4.0'
      DV(6) = '6.0'
      DV(7) = '10.'
      DV(8) = '15.'
      DV(9) = '20.'
      DV(10)= '30.'
;
;  ---------------- Load the COG Menu Options ------------------------
;
   c_opts    = string(bytarr(26,8))
   c_opts(0) = 'Options:'
   c_opts(1) = 'Compare 1st Species to COG'
   c_opts(2) = 'Add another species to COG'
   c_opts(3) = 'Send Plot to Laser Printer'
   c_opts(4) = 'Stop - Temporary Halt'
   c_opts(5) = 'Adjust Plotting Limits'
   c_opts(6) = 'Adjust # of Theo. Curves'
   c_opts(7) = 'Quit and Return'
;
;  --------------- Load Plotting Symbol Options ----------------------
;
   s_opt    = string(bytarr(16,9))
   s_opt(0) = 'Plotting Symbols'
   s_opt(1) = 'Plus sign'
   s_opt(2) = 'Asterisk'
   s_opt(3) = 'Filled Circle'
   s_opt(4) = 'Diamond'
   s_opt(5) = 'Triangle'
   s_opt(6) = 'Square'
   s_opt(7) = 'X'
```

```
   _opt(8) = 'Open Circle'

;
;  -------------- To get number of curves options --------------------
;
   nns     = string(bytarr(11,11))
   nns(1)  = '<  1 >'
   nns(2)  = '<  2 >'
   nns(3)  = '<  3 >'
   nns(4)  = '<  4 >'
   nns(5)  = '<  5 >'
   nns(6)  = '<  6 >'
   nns(7)  = '<  7 >'
   nns(8)  = '<  8 >'
   nns(9)  = '<  9 >'
   nns(10) = '< 10 >'
;********       END OF FIREUP
RETURN
END
;
;
;
;
;
PRO LINES,A,NT,NS,M,H,L,T,B,X,EQL,libr,which
;******************************** LINES.PRO  ***********************************
;
;       TO GET AND PLOT THE CURVES FOR  C.O.G.
;
;       by Charles L. Joseph                          5/17/79
;*****************************************************************************
     if (T eq 0.) AND (B eq 0.) then begin              ; If NOT Scaling Override
tst = max(EQL)                                         ; Test for only weak &
if (tst lt -5) then begin                              ; Set plot limits,
    T = -3.0                                           ; accordingly.
    B = -7.0
    L = 10.
    H = 16.
        end else begin                                         ; Only strong-lines-case
    T = -2.                                            ; plotting limits.
    B = -6.
    L = 11.5
    H = 18.
endelse
     endif
     ERASE
     A = libr+'/tabdata/feii2382.tab'
     A = libr+'/tabdata/siii1260.tab'

     OPENR,1,A
     y = fltarr(10)
     yy = fltarr(10,41)
```

```
    xx = fltarr(41)
    for k=0,40 do begin
        readf,1,format='(f9.3,10(f13.4))',x,y
yy(0:9,k) = y
xx(k)     = x
    endfor
    close,1
    NA=NS+NT-1
    FOR M=NS,NA DO BEGIN
 y = yy(M-1,0:40)
        IF M EQ NS THEN PLOT,xx,y,xrange=[L,H],yrange=[B,T], $
    XTITLE='!3log (Nf!4k!3)',YTITLE='!3log (W/!4k!3)'
        IF M GT NS THEN OPLOT,xx,y
    END
;   XYOUT,400,30,'log N ( cm -2 )'
;   YXOUT,0,600,'log  eqw/ lambda'
    CLOSE,1
;   !PSYM=1
    M=0
RETURN
END
;
;
;
;
;
PRO GRAB,STAR,C,IAF,WF,EQL,MEL,WAF,F,W,EQW,NL,ML,ME,L,dtl,cnum
;
;********************* GRAB.PRO ***********************************
;
;       TO GET THE EQW DATA FROM THE  .DTL  FILE
;
;       WRITTEN BY  C. JOSEPH     1980
;
;        MODIFIED BY C. JOSEPH AND T. ARMITAGE ON 19 MAY 1983
;           TO HANDLE A SINGLE OBSERVED EQUIVALENT WIDTH
;
;
;*********************************************************************
;
     OPENR,1,STAR+'.DTL'                          ; Open data file and read
     readu,1,dtl                                  ; observed data.
     close,1
     iafs = where(dtl.iaf eq iaf)                 ; Get addresses of desired data.
     NL = size(iafs)                              ; Get Number of Lines and put
     NL = NL(1)                                   ; value in NL.

     W   = dtl.wl                                 ; Get those portions of the
     F   = dtl.f                                  ; .DTL file to be used.
     EQW = dtl.eqw
     ME  = dtl.me
```

```
      if NL gt 1 then begin
        W   = W(iafs)                          ; Strip out only those measure-
        F   = F(iafs)                          ; ments for the give species.
        EQW = EQW(iafs)
        ME  = ME(iafs)
      end else begin                           ; If there is only one measure-
tmpw = W(iafs)                                 ; ment, make 2-elm. array of it.
tmpf = F(iafs)
tmpe = EQW(iafs)
tmpm = ME(iafs)
W   = fltarr(2)
F   = fltarr(2)
EQW = fltarr(2)
ME  = fltarr(2)
W(0:1) = tmpw
F(0:1) = tmpf
EQW(0:1) = tmpe
ME(0:1)  = tmpm
NL  = 2
      endelse

      WAF = ALOG10(W*F)                        ; Calculate log f-lambda's.
      EQL = ALOG10(EQW/W)                      ; Take log of equivalent widths

      MEL=FLTARR(2,NL)
      FOR N=0,NL-1 DO BEGIN
           IF ME(N) NE -1000 THEN MEL(0,N) = (EQW(N)+ME(N))/W(N)
           IF ME(N) NE -1000 THEN MEL(1,N) = (EQW(N)-ME(N))/W(N)
           IF ME(N) EQ -1000 THEN MEL(0,N) =  EQW(N)/W(N)
           IF ME(N) EQ -1000 THEN MEL(1,N) = (EQW(N)-17)/W(N)
      END
      MEL=ALOG10(MEL)
      SS = L + 1 - WAF*(F GT 0)                ; Shift points so they are on
      WF=WAF+MIN(SS)                           ; the COG plot.
FIN: RETURN
END
;
;
;
;
; ****************************** PLOTEM.PRO ******************************
;   To overplot the various species equivalent widths plus error bars.
;   By Charles L. Joseph                                    5/15/90
; ************************************************************************

pro plotem,wfsav,eqlsv,symnum,melsv,n_opt,snum,INUM
     asy = findgen(16)*(!PI*2/16.)             ; Used for plot symbol.
     DX = fltarr(2)
     for k=0,INUM do begin                     ; For each species, over
         teql = eqlsv(k,0:19)                  ; plot with correct symb.
         tst  = where(teql ne 0,NL)            ; Get addresses of valid
         teql = teql(tst)                      ; data and strip out.
```

```
      twf  = wfsav(k,0:19)                                ;
      twf  = twf(tst)                                     ; Strip out  log(fW).
      tme = melsv(k,0:1,0:19)                             ;
      tme = tme(0,0:1,tst)                                ; Strip out Mean Errors.

      if symnum(k) eq 3 then begin                        ; Make special symbols?
 usersym,0.7*cos(asy),0.5*sin(asy),/FILL    ; Convert dots to open
 tsym = 8                                   ; circles.
      end else begin
         usersym,0.7*cos(asy),0.5*sin(asy)                ; Option for open circles.
         tsym = symnum(k)                                 ; Most cases, take IDL's.
      endelse
      OPLOT,twf,teql,PSYM=tsym                            ; Over plot obs. DATA
      for N=0,NL-1 do begin                               ; Over plot Error Bars.
  DX(0:1) = twf(N)
  DY =  tme(0,0:1,N)
  OPLOT,DX,DY
      endfor                                              ; END Error Bars part.
   endfor

   if INUM gt 0 then begin                                ; If more than one species,
      Y2      = fltarr(2)                                 ; make symbol key at left.
      yrng  = !y.crange(1) - !y.crange(0)                 ; Get range of plot so that
      xrng  = !x.crange(1) - !x.crange(0)                 ; the KEY can be positioned
      xout1 = 0.10*xrng + !x.crange(0)
      xout2 = 0.13*xrng + !x.crange(0)
      if INUM lt 5 then tymx =0.75 else tymx=0.85         ; Lots of obs.? Adjust TOP
      DX(0:1) = xout1                                     ; Stuff 2-elm. X array.
      for k=0,INUM do begin                               ;
          if symnum(k) eq 3 then begin                    ; Make special symbols?
             usersym,0.7*cos(asy),0.5*sin(asy),/FILL ; Convert dots to open
             tsym = 8                                     ; circles.
          end else begin
      usersym,0.7*cos(asy),0.5*sin(asy)          ; Option for open circles.
      tsym = symnum(k)                           ; Most cases, take IDL's.
          endelse
   tdy = (tymx-0.05*(INUM-k))*yrng + !y.crange(0)  ; Y-position for next.
   Y2(0:1) = tdy                                 ; Stuff 2-elm. Y array.
   oplot,DX,Y2,PSYM=tsym                         ; Over plot the symbol.
   spe = n_opt(snum(k))
   tdy = tdy - 0.01*yrng
   xyouts,xout2,tdy,spe                          ; Print species name.
      endfor
    endif                                                 ; END KEY-making part.
return
end
;
;
; ********************* WHICHCOGS.PRO ****************************************
;
;   To determine starting and how many theoretical C.O.G. are to be used.
;   By Charles L. Joseph                                  5/15/90
```

```
;
; ***************************************************************************

pro whichcogs,nns,NS,NT
print,string(7B)                                    ; Which C.O.G.'s to use?
print,'Indicate the total number of theoretical Curves of Growth
print,'that are to be plotted.  (1 - 10)'
print,'The b values are: 1.0, 1.5, 2, 3, 4, 6, 10, 15, 20, and 30'
print,'km/s, respectively'
nns(0) = '# of Curves?'
wait,1
NT     = wmenu(nns,title=0,init=10)
if NT lt 1 then NT = 1
print,' '
print,'Indicate the curve number for the C.O.G. with the lowest'
print,'b value to be plotted.  (e.g. use 2 to get the 1.5 km/s.)'
nns(0) = 'Starting?'
NS     = wmenu(nns,title=0,init=1)
if NS lt 1 then NS = 1                              ; Make sure range range
if NT gt (11-NS) then NT = 11 - NS                  ; makes sense.
return
end
;
;
; ########################## END OF COG PACKAGE ##############################
```

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ii. All modified code must indicate the original author, author's affiliated institution, and a modification history including each and every major participant involved in the modification.

iii. If the altered code is designed to override a particular behavior of standard MSLAP, a concise description of the former and new behavior must be output in a conspicuous manner and also included in the source code documentation.

iv. The ALT_INT routine has special rules. This routine is used to provide an alternate type of integration. The following disclaimer must appear in a conspicuous manner whenever the routine is called. Standard MSLAP with a working instruction window at the lower left of the screen automatically produces this disclaimer. The following lines from that disclaimer are listed below and may NOT be removed from the file intgrt.pro.

```
print,' ',string(7B)
print,string(7B),'No Alternate Integration Routine is Provided'
print,'in standard M.S.L.A.P. - version 1.0'
print,' '
print,'Origin of the Alt. Integration Routine is as follows:'
```

7. A library of user-generated data-getting routines are made available to the astronomical community and users are encouraged to add to this library. MSLAP supports any combination of 5 or less of these routines at one time. (See the MSLAP Documentation Manuel for the general implementation of dget1, dget2, dget3, dget4, and dget5 procedures and their appropriate protocols.) All "dget" routines are considered to be formally outside of MSLAP and not subject to the terms of this Agreement. However, it is strongly recommended that the documentation rules listed above be implemented to maximize the overall utility of any user-contributed routines for data retrieval.

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Some version of the original file mslap.pro must be retained and be made available to individual users for their personal customization of MSLAP.

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APPENDIX B

Data Structures in MSLAP

There are 3 structures used by MSLAP, "mp","mcntrl", and "dtl". All three are global in nature, meaning they can be accessed from any subroutine. The first, "mp" is the primary structure and the one most frequently used to modify a particular behavior of MSLAP. "mcntrl" is a second structure used primarily for record keeping and some control. Greater care should be exercised in make adjustments to "mcntrl" since MSLAP could become "confused" and may lead to spurious results that may not be obvious. This structure ("mcntrl") is intended for the advanced user of MSLAP. The final structure is "dtl", which contains the measurements that are written to the output data file. This "dtl" structure can be edited using option 4 in the beginning Main MSLAP Menu. Below is a list of the parameters along with a description of each.

The primary (non-data storage) structure used by MSLAP is "mp", MslapParameter.

---

mp.dget - a flag used to indicate the presence of a dget routine. During the setup stage, MSLAP calls each dget routine (i.e. dget1, dget2, ..., dget5). At this time mp.cntrl equals -1, a flag to indicate the initial call. If the user-installed dget routine is to be recognized by MSLAP, it must return mp.dget not equal to zero on this initial call. The dummy dget routines leave mp.dget=0.

mp.cntrl - The control flag for MSLAP operations. Some care should be exercised when changing the value of mp.cntrl in any USERPROG, but generally speaking mp.cntrl can be safely set in any DGET.

mp.cntrl = -1 => This is the first time the dget routine is being called. Hardware graphics are configured.
mp.cntrl = 1 => No problems have been encountered in the sub-routine. OK flag for storing the measurement.
mp.cntrl = -99 => Abort Condition, MSLAP will exit.
mp.cntrl = -10 => Make HardCopy Flag.
mp.cntrl = 0 => Subroutine Returned as if NEVER CALLED. MSLAP will just replot spectra and start over.
mp.cntrl = 2 => Get NEXT Spectra.

mp.order - is used for echelle spectra. It can be used to select a portion of the spectra when more than one record is placed in a given data file. (Standard MSLAP does not make use of this parameter; it is supplied solely for the user's convenience [e.g. it can be displayed using plotlab1 or 2.])

mp.CAM - Specifies a camera number. Many satellites have more than one

camera and it is often useful to record this information. (Standard MSLAP does not make use of this parameter; it is supplied solely for the user's convenience [e.g. it can be displayed using plotlab1 or 2.])

mp.SMO - a flag that causes the graphics to smooth the data by a 3 point running box car. (This feature is becoming obsolete and may not be available in future versions of MSLAP.) It is best to perform any smoothing inside the user's DGET or USERPROG routine and then adjust the mp.cohfac value accordingly.

mp.cohfac - the coherence factor of the noise in the data. (See MSLAP the Manuel for details.) Basically, this is a measure of the linear independence of the one pixel to other nearby pixels. For example, data that have been smoothed by a 5-point running box car would have a coherence factor of 5.

mp.bg - the background level, if not zero.

mp.bgerr - the 1-sigma uncertainty in the background level. This value is VERY IMPORTANT since in many applications this error is the dominant source. (See the MSLAP Manuel for details.)

mp.window - this parameter is used to define a fixed-sized integration window. In data with poor signal-to-noise ratios or in cases where the intrinsic strength of a spectral feature is expected to be weak compared to the noise, this feature of MSLAP allow the user to make unbiased measurements of the signal strength based on info. obtain from other spectral features. This parameter is set and/or used in response to the MENU option which selects the order of the polynomial to fit the continuum. (See the MSLAP Manuel for information regarding the "Predetermined Window" option.)

mp.DTY - a parameter with integer values in the range [1, ...,5] which selects which [DGET1, ..., DGET5] routine will be called.

mp.STAR - Contains the Output File name. This string plus the ".DTL" extension form the primary output data file that MSLAP creates.

mp.FNAM - Contains the Input File name from which the spectral data will be retrieved. This string may include a directory path as well.

mp.poly - Holds the order number of the polynomial that was used to fit the continuum.

mp.SNR - is the APPARENT Signal-to-Noise Ratio. It is the RMS value of the residuals of the real data minus the polynomial fit. The Real SNR is obtained by dividing mp.SNR by the square-root of the the coherence factor [i.e. Real SNR = mp.SNR/(mp.cohfac^0.5)]. This

RMS value is added in quadrature with the mp.bgerr to estimate the total uncertainties.

A structure called "mcntrl" is primarily used for record keeping while MSLAP is running. It is recommended that only advance users of MSLAP adjust these parameters.

---

mcntrl.I - is the pointer of the number of measurements that have been made. If a "output.DTL" file exists at start up, this file is opened and mcntrl.I is set to the number of non-zero data entries. The user is then prompted to accept or reinitialize this pointer.

mcntrl.date a string holding the date obtained from the system clock.

mcntrl.intopt an integer flag indicating which integrating routine is to be used. Normally, mcntrl.intopt=1. If mcntrl.intopt=0, the ALT_INT routine is called.

mcntrl.NNE the number of continuum points used in the polynomial fit and in the uncertainty calculations.

mcntrl.ESAV the RMS uncertainty, calculated from the residual differences between the real continuum and the polynomial fit.

mcntrl.e0 Background's contribution to the zeroth moment (Equivalent Width). If multiple measurements are made simultaneously, only the first measurement is stored in this parameter. The same is true for mcntrl.e1 and mcntrl.e2

mcntrl.e1 same as mcntrl.e0, except it is for the first moment.

mcntrl.e2 same as mcntrl.e0, except it is for the second moment.

mcntrl.wtol wavelength tolerance used in testing for a match between the selected observed wavelength and comparison to the USER Look Up Table of rest wavelengths. Normally, this is taken to be 10 spectral elements wide or 0.5 Angstroms, which ever is largest.

mcntrl.libr a string holding the main "library" directory of routines and tabled data.

mcntrl.mtot the largest polynomial that will be fit by MSLAP. Standard MSLAP uses mcntrl.mtot=5. A larger value will automatically fit corresp-

dtl.fm Holds all of the First Moments of the profiles.

dtl.fme Holds all of the Errors associated with the First Moments.

dtl.sm Holds all of the Second Moments of the profiles.

dtl.sme Holds all of the Errors associated with the Second Moments.

dtl.com Holds all of the byte arrays containing the information that was entered as comments. This part is similar to dtl.el above.

dtl.up Holds all of the UserParameter Arrays. Each dtl.up holds a 30 element floating-point vector that is reserved for the user's exclusive use.

MSLAP SITE LICENSE AGREEMENT

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5. A set of routines, contained in the file mslap.pro, are designed for individualized customization of MSLAP. You are permitted to create new modules (subroutines) of the USERPROG's or to make adaptations of the routines originally found in the file mslap.pro, and to distribute these customized modules to other sites, provided the new code meets the requirement in section 6.

6. Any and all modifications must comply with the following:

i. All modified code must describe all parameters in each procedure definition statement.

ii. All modified code must indicate the original author, author's affiliated institution, and a modification history including each and every major participant involved in the modification.

iii. If the altered code is designed to override a particular behavior of standard MSLAP, a concise description of the former and new behavior must be output in a conspicuous manner and also included in the source code documentation.

iv. The ALT_INT routine has special rules. This routine is used to provide an alternate type of integration. The following disclaimer must appear in a conspicuous manner whenever the routine is called. Standard MSLAP with a working instruction window at the lower left of the screen automatically produces this disclaimer. The following lines from that disclaimer are listed below and may NOT be removed from the file intgrt.pro.

```
print,' ',string(7B)
print,string(7B),'No Alternate Integration Routine is Provided'
print,'in standard M.S.L.A.P. - version 1.0'
print,' '
print,'Origin of the Alt. Integration Routine is as follows:'
```

7. A library of user-generated data-getting routines are made available to the astronomical community and users are encouraged to add to this library. MSLAP supports any combination of 5 or less of these routines at one time. (See the MSLAP Documentation Manuel for the general implementation of dget1, dget2, dget3, dget4, and dget5 procedures and their appropriate protocols.) All "dget" routines are considered to be formally outside of MSLAP and not subject to the terms of this Agreement. However, it is strongly recommended that the documentation rules listed above be implemented to maximize the overall utility of any user-contributed routines for data retrieval.

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Some version of the original file mslap.pro must be retained and be made available to individual users for their personal customization of MSLAP.

If you modify any portion of MSLAP including the original file mslap.pro to override a particular behavior of standard MSLAP, a concise description of the former and new behavior must be output in a conspicuous manner when MSLAP is running and also must be included in the source code documentation.

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Date and Signature of Charles L. Joseph, the first author.

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